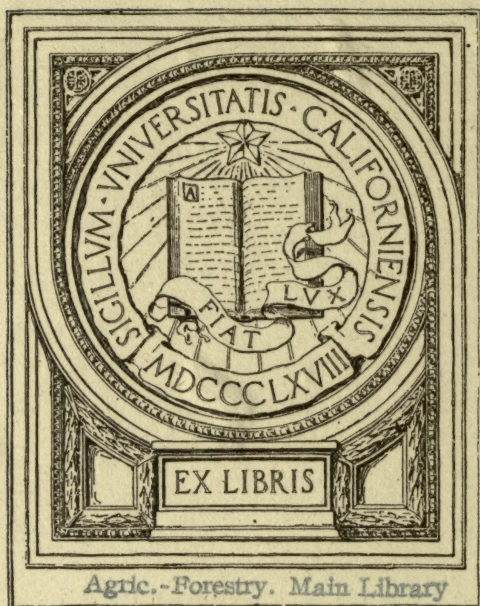


Pamphlets on Forestry in Texas.

Forestry Pamphlets

TEXAS

VOL. I

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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY,
Washington, D. C., April 23, 1904.

SIR: I have the honor to transmit herewith a report entitled "The Timber of the Edwards Plateau of Texas; Its Relation to Climate, Water Supply, and Soil," by William L. Bray, collaborator in the Bureau of Forestry, and to recommend its publication as Bulletin No. 49 of the Bureau of Forestry.

The map and five plates which accompany the report are necessary for its proper illustration.

Very respectfully,

GIFFORD PINCHOT,
Forester.

HON. JAMES WILSON,
Secretary of Agriculture.

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THE TIMBER OF THE EDWARDS PLATEAU OF TEXAS; ITS RELATION TO CLIMATE, WATER SUPPLY, AND SOIL.

INTRODUCTION.

That a forest or other heavy growth of vegetation exerts an important influence in conserving the water supply, in preventing or checking floods, and in resisting the erosion of soil, scarcely requires demonstration in these pages. Most Texans, at any rate, have had abundant opportunity to observe how a heavy growth of grass on prairie slopes will hold the soil at the time of a heavy cloudburst, which, on denuded soils, plows out great gulches and carries away thousands of cubic yards of earth. Or those living in the rough, mountainous region of south-central Texas may have noticed how, after a violent downpour of rain, the water rushes down the sides of bare, steep hills with a power which carries not only any remnants of soil, but the fragments of rock as well, and scoops out the bottom of the gorge down to a solid rock bed; whereas when the sides of the gorge and perhaps the hills above are heavily timbered, the organic *débris* drinks up and detains the water, so that not only is this heavy covering of leaf mold not washed away, but the water does not acquire momentum and volume sufficient to sweep out the channel of the gorge itself.

Older communities, after costly experience with floods, with the failure of springs and streams, and with the destruction of valuable farming areas, acknowledge that there are some areas from which forest covering must not be removed. It is quite within experience that the difference between two similarly located regions, one of them abounding in fertile farms and orchards and pastures, the other a bare waste of naked hills and water-washed lowlands, may be due to the treatment given to the native forest vegetation which, to begin with, covered the hillsides. Our neighbors of the older States of the South who live in the Coast Plain forest belt of sandy clay soils (the same as the Lignitic Belt of Texas) realize, after the loss of whole farming areas by erosion, that, within this region at least, certain portions must be left timbered for the protection of farm lands. It is a familiar fact that in the south of France, when the short-sighted policy of selling the Government forest lands and permitting their denudation

was adopted after the Revolution, whole regions were reduced from fertile farms and vineyards to barren wastes, and that within recent years the policy has been pursued of reclaiming these lands by reestablishing the forest covering, though at an enormous expense. Some of the same conditions and possibilities exist in the region which we are to consider in this bulletin.

THE EDWARDS PLATEAU AS A SOURCE OF WATER SUPPLY.

The water supply furnished by the rainfall of the Edwards Plateau is important not only for its own area, but especially for the coast plain lying to the southeast and south of it. The plateau is a vast receiving or catchment area for water, the major portion of which is given up to the plain, either immediately, in the form of destructive floods, or gradually, in the form of steadily flowing or intermittent streams or artesian water. The great Rio Grande Plain from the Colorado to the Rio Grande is a level, irrigable area, whose richness of soil and mildness of climate mark it as one of the endlessly resourceful and productive regions of the country, if only it can get water enough. Its relation to the interior highlands of the Edwards Plateau (see relief map, frontispiece) is therefore one of extreme importance. While no pretension is here made to such a treatment of this subject as would fall to a hydrographic engineer, it is nevertheless possible to point out how the forest growth of the plateau affects the supply of water, and how through its agency the supply may be improved.

DESCRIPTION OF THE REGION.

The Edwards Plateau is the southernmost province of the Great Plains region, which comes to an abrupt termination in the escarpment known as the Balcones escarpment—a line of cliffs formed by a gigantic downthrow or faulting. These cliffs constitute the front line of the hill region one sees so clearly marked from Austin to San Antonio, and thence westward to Del Rio. Strictly speaking, the plateau is arbitrarily bounded by the canyon of the Pecos River on the west, and on the northeast by the escarpment overlooking the central denuded area (the Granite country, etc.); but in this bulletin the discussion includes as well all of the adjacent area of the Central Denuded Region and the rougher eroded and timbered parts of the Grand Prairie from the Colorado northward, since they have the same relation to water supply as the more limited plateau proper.

According to Hill^a the Edwards Plateau proper includes all of Crockett, Valverde, Edwards, Sutton, Schleicher, Kimble, Kerr,

^aHill and Vaughan. The Edwards Plateau and Rio Grande Plain (p. 205), Eighteenth Ann. Rpt. U. S. Geological Survey, Part II.



FIG. 1.—VIEW OF TIMBER (MOSTLY CEDAR) ON WHITE, CRUMBLY LIMESTONE; HIGHER REMNANTS OF PLATEAU IN DISTANCE.

No soil accumulates except under clumps of cedar. Colorado breaks 10 miles north of Austin.



FIG. 2.—COMAL RIVER AT ITS SOURCE—ESCARPMENT TIMBER.



FIG. 1.—CHARACTERISTIC VIEW OF THE EDWARDS PLATEAU FOREST, ON THE COLORADO RIVER, 10 MILES ABOVE AUSTIN.

Mostly cedar on the summits here. Mountain oak lower down the sides of the gorge. This timber prevents rapid run-off and erosion after rainfall.



FIG. 2.—HILL NEAR AUSTIN COVERED WITH PURE STAND OF MOUNTAIN OAK.

On the left the timber has been cut clean for fuel. Such clearings show rapid renewal of timber.

Bandera, Gillespie, Kendall, and Blanco counties, as well as half of Crane, Upton, Tom Green, Irion, Concho, Menard, Travis, Hays, Comal, Bexar, Medina, Uvalde, and Kinney counties. This area is a part of the great limestone region which constitutes the southern province of the Great Plains. To the northwest it is continuous with the Staked Plains, and is a typical open, level plains country. Farther southward, however, the area is far advanced in the process of erosion, being deeply dissected by streamways flowing southeastward and cutting the margin into long, narrow tongues of the former plateau mass. In the dissected border are also hundreds of remnantal buttes or hills, like Mount Bonnel and Lone Tree Hill at Austin, Long Mountain, Post Mountain, Pack Saddle, etc.^a (See frontispiece and Pl. I, fig. 1.)

The Edwards Plateau (Eighteenth Ann. Rpt. U. S. Geological Survey, p. 206) presents three simple topographic elements: (1) The flat-topped summits of the decaying plateau (the divides); (2) the breaks and slopes of its crenulated borders and canyoned valleys ("the mountains"); and (3) the streamways or rivers and their branches.

The escarpment front rises to an elevation above the Coast Plain of from 400 feet at Austin to 1,000 feet in Uvalde County, while the northwest is a high plain 2,400 feet above the sea. Naturally, it is chiefly in the eroded or mountainous portion of the plateau that a protective timber growth is needed.

For our present purpose the important considerations concerning the Edwards Plateau are, that it is a vast receiving area for rainfall, and that its structure is such as to give special significance to the behavior of water after it has been precipitated.

STRUCTURE OF THE EDWARDS PLATEAU AS A CATCHMENT AREA.

Until the report by Messrs. Hill and Vaughan was published there seems to have been no general recognition that this limestone country played a rôle of consequence as a receiver of precipitated water. The report showed, however, that, as a matter of fact, its capacity to take up water is of the first importance; and that this is possible not only because of the specific absorption capacity of the limestones themselves, but also by reason of the favorable exposure (by erosion and normal outcrop) and the tilting of the strata, and especially by reason of the very extensive systems of fissures and caverns, which contribute remarkably toward rendering the formation receptive of water.

^aHill and Vaughan. Artesian Water of the Edwards Plateau, etc., Eighteenth Ann. Rpt. U. S. Geological Survey, Part II.

The above report has been used freely in the preparation of this bulletin, and grateful acknowledgment is hereby made of the author's indebtedness to it.

STRUCTURE OF THE EDWARDS PLATEAU AS TO INFLUENCING THE
BEHAVIOR OF THE PRECIPITATED WATER.

We have just seen wherein the structure of this formation renders it an efficient catchment area. The same structure operates to convey a large part of the water to the deeper strata, whence it reappears as spring water to feed the rivers flowing from the region.

The topography has, however, from our present point of view, an even more important bearing; since by it are determined in large measure the rapidity of run-off and the percentage of precipitated water lost in this way. Since the border region of the plateau is very rough and deeply dissected, the water will flow off after heavy rainfall before it has had time to enter the limestone formation; and with such volume and velocity as to cause swift and destructive floods, unless detained by some agency other than the limestone structure of steep hillsides. This is exactly the function which a timber or heavy grass covering performs (Pl. II, fig. 1).

CLIMATIC CONDITIONS OF THE REGION.

The climatic conditions are of significance in this discussion: First, because they determine the actual amount of rainfall and influence its behavior after falling, e. g., its rate of evaporation; second, because they determine very largely the character of the vegetation, with whose efficiency as a water conserver we are mainly interested.

RAINFALL.

The region under consideration lies in the belt of transition from moderately heavy rainfall to arid climate, with a very pronounced difference between the eastern and the western borders. Thus, at Austin, the average is nearly 33 inches annually, while on the Pecos side it sinks to about 15 inches. But the more important part of the area for our purpose receives an average annual rainfall not much below 25 inches, which, if well distributed and available, would be ample for agriculture.

The manner in which the rainfall comes is next in importance to the total quantity of it, because of its relation both to the percentage and velocity of run-off and to the checking power which a forest covering could exert. It happens that the Edwards Plateau region is in a zone of fluctuation as regards the type of rainfall; so that when, for example, the Eastern Gulf type prevails, as during the winter of 1902-3, a very heavy season of rainfall may occur entirely unaccompanied by destructive floods, while, on the other hand, an equally heavy season's rain may fall in a very few heavy downpours between April and July. An example of the latter was in 1900, when repeated destructive floods occurred. The amount of precipitation within a brief period may be

extraordinary. Thus, at Fort Clark, toward the western border of our area, the June rainfall of 1900 was 22.32 inches, of which over 16 inches fell within twenty-four hours. During the same month, in 1899, occurred the great Brazos River flood, in connection with which the rainfall of a period of three or four days at Waco exceeded 18 inches.

Mr. Hill, in *The Physical Geography of Texas* (p. 11), calls attention to the recurrence of flood periods:

This combination of overlapping conditions in the provinces mentioned, and the accompanying meteorologic phenomena, produce peculiar climatic conditions productive of erratic floods, which have an important bearing on the agricultural interests, and have, no doubt, been a factor in the peculiar erosion of the denuded central province.

ATMOSPHERIC MOISTURE.

The relative humidity and the evaporation capacity of the air have significance, also, both for the behavior of the precipitated moisture as affected by its rate of evaporation and for the occurrence of a protective vegetation; since the drier the air the more open and stunted the timber or other growth.

During most of the year the Edwards Plateau climate is dry. Even at Austin the average number of actually humid days during the year is small. From Burnet, Fredericksburg, and San Antonio westward the dryness of the air is notable—so much so that invalids requiring dry atmosphere resort thither—while in the Devils River country the air has the dryness and, in the summer, the parching heat of the desert. On the average, the evaporation capacity of the air over this region is sufficient to remove annually a free layer of water over 50 inches deep; which means that if the water which falls over the area were continuously and freely exposed as the surface of a lake, this thirsty air could drink it up twice over in one year.

We shall see later how a heavy timber covering operates to check this loss of water from the soil.

WATER SUPPLY OF THE EDWARDS PLATEAU.

This vast limestone country is the receiving area for an annual rainfall sufficient to cover its entire 15,000 square miles of territory with a sheet of water 2 feet deep. The important question is, what becomes of this water? If most of it runs off speedily it is, of course, lost to the region and its adjacent coast plain, so far as benefiting the growth of vegetation is concerned. If, on the other hand, it is detained to be doled out gradually by the limestone formation, its possibilities for plant life are enormously multiplied. As a matter of fact, the quantity lost by a rapid run-off no doubt materially exceeds that retained by the earth strata. But this, we have seen, is dependent upon certain

conditions; especially upon the manner in which the rainfall comes, the topography of the area (the run-off being greater in the country of steep slopes and deep canyons than on the level uplands, unless it should happen, that here the rock strata are flat, unbroken, and impervious), and upon the presence of hindrances to rapid run-off which detain the water until more of it sinks into the earth. The physical action of this flood water has been the principal agent in causing the dissection of the ancient plateau into its present aspect of hills and canyons. The drainage channels cut by the run-off waters constitute the present river systems of the area. (See frontispiece.)

RIVERS.

Two classes of streams are to be distinguished: (1) Those having their origin within the plateau area and cutting deep canyons in it before emerging upon the Coast Plain; (2) those which rise at the base of the escarpment, and which consequently, although owing their water supply to the plateau region, are structurally features of the Coast Plain.

Of the former class the Colorado is the foremost; for, although it heads in the Red Beds and Staked Plains, it is to be regarded in the main as a drainage system of the Edwards Plateau, from which it receives not only its major branches, the San Saba, Llano, and Peder-nales, but also several important minor ones, like Beaver, Sandy, Spring, Cypress, Barton, and Onion creeks. Next in sequence westward come the Blanco, the San Marcos, and the Guadalupe, of which the last two receive strong reinforcements from the San Marcos and Comal springs, respectively, as they emerge from the plateau. West of San Antonio come, in order, the Medina, Hondo, Sabinal, Frio, Nueces, and Devils rivers. In the case of all of these except the Colorado, Guadalupe, and Devils rivers, while there are constantly flowing springs and water holes within the plateau area, the water, upon emerging from the escarpment, especially during dry seasons, often entirely sinks out of sight in the broken limestone bed, reappearing farther toward the coast. In the three exceptions named there is a flow which, though subject to fluctuations with the season's rainfall, is at all times relatively strong.

Of the second class of streams are the San Marcos, as reenforced by San Marcos Springs; the Comal, fed by Comal Springs; the San Antonio, fed by a series of springs; Los Ulmos, heading in the springs at Fort Clark; and the San Felipe, heading at Del Rio in the San Felipe Springs. In all these rivers the flow is remarkably constant, though naturally fluctuating somewhat with longer periods of drought or excessive rainfall. The quantity of flow will be found in the table of flow of springs on page 14.

All of these streams, but more especially the first group, which cut through the plateau, are channels for the flood waters of the region, which frequently descend with great volume and velocity, causing serious losses. Their permanent flow, however, is sustained by the springs of the region, which are fed by the retained waters. This leads us next to an inquiry as to the water-receiving capacity of the Edwards Plateau limestones. We have seen above that not only are the edges of the successive strata exposed either by normal outcrop or by erosion, but that the strata are much interrupted by clefts and fissures, minor faultings, and caverns, until the entire area possesses a very large capacity to take up the precipitated water. The magnitude of these fissures may be appreciated when one observes such volumes of water as that which flows from Kickapoo Springs suddenly disappear in the limestone bottom of the creek bed—a phenomenon also to be observed in the Nueces, and, indeed, in most of the minor tributaries of the region indicated above where they emerge upon the Coast Plain.

SPRINGS.

Some of the water retained by the limestones and their superficial soils is removed by evaporation, of whose intensity we have already learned. Some of it sinks to subterranean reservoirs and does not reappear unless the reservoir is tapped, when either nonflowing or artesian wells result. The rest reappears in the form of springs, of which Hill and Vaughan (p. 307) distinguish two types—gravity springs and fissure springs.

GRAVITY SPRINGS.

These springs are characteristic of the region itself; and are simply the flow of water from exposed rock strata in the natural course of seeking its level. Such springs form the heads of the various streams of the region. The famous Kickapoo Springs at the head of the west fork of the Nueces are an example.

FISSURE SPRINGS.

On the southern and eastern margin of the plateau is a line of springs which extends from Del Rio to San Antonio, and thence along the escarpment border to Austin and northward. These are fissure or artesian springs, whose flow is due to hydrostatic pressure. The water is forced up through the fractures caused by the gigantic downthrow or faulting which caused the escarpment itself. So great is the flow from some of these springs that full-fledged rivers boil from the earth within the space of a few square rods (Pl. I, fig. 2).

An approximation of the run-off from these springs may be had from the table following, taken from the geological report of Hill and Vaughan (p. 311).

TABLE I.—*Discharge of spring rivers arising from fissure springs.*

Date.	Streams.	Discharge per second.	Discharge per 24 hours.
1895.		<i>Cubic feet.</i>	<i>Gallons.</i>
December 18.....	Barton Springs.....	25	16, 157, 921
December 18.....	Dam Spring—Austin.....	4. 3	2, 800, 000
December 19.....	San Marcos River.....	89	57, 522, 200
December 20.....	Comal River, New Braunfels.....	328	211, 981, 952
December 21.....	San Antonio River.....	42	27, 145, 308
December 21.....	San Pedro Springs, San Antonio.....	9	5, 816, 852
December 24.....	Los Moros Springs—Fort Clark.....	21	13, 572, 653
December 24.....	Del Rio Ditch.....	19	12, 280, 021
December 24.....	San Felipe Springs—Del Rio.....	80	51, 705, 350
December 24.....	Guadalupe River, before junction with Comal.....	48	31, 023, 210
December 23.....	Sabinal River.....	0. 6	387, 790
December 23.....	Leona River.....	11	7, 109, 486

THE VEGETATION OF THE EDWARDS PLATEAU.

GENERAL DESCRIPTION.

The character of this vegetation is very clearly a product of climatic and geologic conditions. These combine to give it the stamp befitting an arid or at least a semiarid environment. Its structure and habits indicate that it is a xerophytic or dry climate vegetation; but though this is true of it as a whole, conditions vary enough to give in some places, as in well-watered and sheltered canyons, a relatively luxuriant growth, while in other situations, as upon stony arid slopes, there is the scantiest vegetation, by no means sufficient to hide the white glare of the chalky soil (Pl. III, fig. 2). On the western border of the region the vegetation bears a markedly desert aspect.

TRANSFORMATION OF PRAIRIE INTO TIMBERLAND.

It is of fundamental importance to note that the type of vegetation in this region is undergoing a change. This change, broadly indicated, consists in a transition from grass to woody growth. This transition is very apparent even to the casual observer. Everyone has observed how the mesquite captures the open pastures (Pl. IV, fig. 2), and many have watched the scrub oak timber occupy uplands that formerly were open prairies.

Some of the causes of this are reasonably evident. In the first place, dissection of the old plateau surface by the process of erosion has favored the establishment of forests in the rougher parts. Progress due to this cause, however, is too slow to be apparent. The presence of trees upward of 500 years old in some of the canyons is an index to the length of time forestation has been in progress. As one passes from the canyons and hills to the level plateau divides, the timber gives place more and more to open prairie, which, until within recent years, was free from woody growth of any kind. But these ranges have been overpastured, and the grass has consequently not succeeded in maintaining a continuous sod, and so has become unable

to wage an equal fight against the shrubs which form the vanguard of the timber vegetation (Pl. IV, fig. 2). Again, settlement has stopped the periodic burning off of the grasses, which, while it left these in a condition to recuperate effectually, drove out the shrubs and prevented the timber from gaining on the prairie.

Nevertheless, in general, the Edwards Plateau is a timbered region only in the deeply eroded portions, becoming prairie on the level uplands, and finally passing into the great grass plains which stretch northward into Canada. One must, however, distinguish many degrees of forestation, according to the relative amount of available moisture. Through a gradual dwarfing and thinning out the timber passes from the big, heavy growth of the watered canyons to the stunted though continuous forest of the hills and bluffs (Pl. II, fig. 1) and the scant tree growth of the loose, stony slopes in the eastern part of the area (Pl. III, fig. 2), until at the west there remains only scattered chaparral, and finally the unique vegetation of the Sotol Country, in which the sotol, cactus, yucca, and agave reign supreme.

THE SPECIES OF TREES AND THEIR GEOGRAPHIC AFFINITIES.

The trees which make up the forests of central Texas—the personnel, so to speak—belong chiefly to the Atlantic type of forest, although Rocky Mountain species and semitropical Mexican species occur also, and in increasing numbers and importance as one goes farther west and southwest. The Atlantic type is represented by elms, live oak, post oak, black jack oak, overcup oak, and basket oak, black cherry, black walnut, pecan, sycamore, green ash, hickory, soapberry, and others. From the southern Rocky Mountain region are the piñon pine, two or three cedars, and several oaks, and from a more southerly range the mesquite, madroña, anaqua (knackaway), *lignum-vitæ*, and others.

Many of the trees of this region are its own peculiar product. Thus, the most abundant species of all, the mountain cedar (*Sabina sabi-noides*), is practically confined to the central Texas limestone country. So also in the case of mountain oak, Mexican persimmon, and so on. Further, while these species are peculiar to the region, they are after all representatives of species ranging farther east in moister climate, and they indicate how the new and more trying environment has practically given origin to new species. The eastern red cedar becomes here the mountain cedar; black walnut is represented by the Mexican walnut, whose nuts are tiny balls scarcely half an inch in diameter. Texas oak becomes mountain oak. The common live oak becomes a new form in its mountain habitat. The common persimmon is represented by the Mexican persimmon, whose fruit is a dark blue-black; Canadian redbud is here also a characteristic “Judas-tree,” but of a different species. The same is true in the case of buckeye, mulberry, hackberry, and still others.

DISTRIBUTION AND CHARACTER OF THE FOREST STAND.

It is not to be inferred from what has been said about the timber vegetation of this region that the Edwards Plateau is covered with continuous forest, even in its rougher parts. On the contrary, the timber is very much interrupted by open, grassy uplands. The present trend, however, is toward a continuous timber covering, and this fact has significance for the future water supply. Recalling the three simple topographic elements comprised in the structure of the region, viz, remnants of the plateau summit (or buttes and divides), mountains, and canyons, we have the basis for classifying the vegetation which forms a covering. This we may now consider more in detail.

TIMBER OF THE CANYONS AND STREAMWAYS.

The tongues of luxuriant forest growth which follow the streamways into the central limestone region are largely extensions of the forests of the Atlantic Plain. In deep, well-watered and sheltered canyons this timber attains large dimensions, and is a thick-canopied, shady forest, under whose protection many shade-loving shrubs and herbaceous plants from the moister Eastern States have established themselves. Thus is constituted a floral community altogether unlike that characteristic of the country roundabout; so that, in a floral zone quite new and strange, one coming from the Atlantic States meets in these canyons so many old friends of his native woodlands that he might easily fancy himself at home. In such places cypress has attained a diameter of 5 feet and over, and sometimes a corresponding height. The American elm, the sycamore, the pecan, the overcup oak, the basket oak, the cottonwood, sometimes the Texas red oak, and the hackberry become here large trees. Of smaller growth are black cherry, box elder, walnut, soapberry, and many others. Beneath these flourish dogwood, spicewood, buckthorn, smoke bush (*Rhus cotinoides*), hollies, and black haw. In the rich, leaf-covered humus the Canadian columbine grows under the ledges, and long fronds of fern overhang the streamlet's edge. This timber on wider bottomland, however, is not so luxuriant nor so like typical Atlantic forest as in narrow sheltered canyons.

THE HILL AND BLUFF TIMBER.

Mixed timber.—This constitutes by far the larger part of the timberland of the region. It abounds on the area of greatest erosion or dissection of the plateau. This is the type of forest occurring, for example, on the breaks of the Colorado, along the escarpment front from Austin westward, and on the Guadalupe, the Pedernales, and the Frio. It extends northward also upon the breaks of the Grand Prairie and the jagged hills of the granite country. The stand of timber



FIG. 1.—VIEW IN A CEDAR BRAKE.

The adobe soil and rocks are covered with a thin layer of brown soil and forest débris, showing capacity of cedar to accumulate soil even on the arid slopes of crumbly limestone.



FIG. 2.—CHARACTERISTIC OCCURRENCE OF CEDAR UPON A STEEP SLOPE COVERED BY LOOSE LIMESTONE TALUS, UPON WHICH MOST VEGETATION IS UNABLE TO ESTABLISH ITSELF.

Dry bed of Bull Creek.

varies in density with local conditions. On lower flats, where the soil is deep and black, there is a heavy mixed timber of cedar, live oak, cedar elm, hackberry, mountain oak, shin oak, and other species. This kind of timber also occupies the side gorges and draws leading out from the main streamways. (Pl. II, fig. 1; Pl. V, fig. 2.) Heavy also, though more stunted, is the timber on the level uplands known as "hardscrabble," where the limestone is hard and breaks in vertical fissures, as for example about McNeil, in Travis County. The same is true on the flat-topped buttes, where the rock is hard and fissured and the soil of good depth. Such timber-capped buttes may be observed on the Colorado 10 miles northwest of Austin, and again on Post Mountain at Burnet, and thence off toward the Colorado below Marble Falls. Where a crumbly limestone underlies the harder cap the timber ceases abruptly on the slope, the broken and unstable débris of this lower formation offering no foothold except for a few of the most hardy plants, like mountain cedar. Such timbered caps stand out in strong contrast with the white, scantily clad or quite bare slopes, and at a distance of many miles one can mark the lower edge of the timber line as clear-cut as if the mountain side had been artificially denuded up to the level of the harder stratum. Very often the harder cap has been wholly removed from the stratum of crumbly limestone, and this weathers into slopes of low gradient. Here an open, dwarfed timber growth establishes itself, generally of mountain cedar. This species, which elsewhere may be so close set as to form almost impenetrable brakes, becomes on this arid and unstable soil or rocky adobe a more open growth of individually rounded out trees. Rarely does the timber occupy these slopes so closely but that their white glare is visible through the foliage (Pl. I, fig. 1). That these slopes, covered with loose débris, may be captured and transformed by woody vegetation we hope to show in a subsequent paragraph. (Pl. III, fig. 2.)

Shinneries.—A special feature of the mixed timber covering on the "hardscrabble" limestone areas is that form of growth which has received the name of "shinnery." Although the shinneries are made up of the mixed timber above mentioned, they are generally thought of as oak shinneries, because of the predominance of dwarf shin oak. They are simply dense thickets which, both because the growth is relatively new and because the conditions are more severe, are scarcely more than tall shrubbery. Such, for example, is the dense thicket covering many square miles of the divide between the Colorado and the San Gabriel drainage valleys, in Burnet County. Much of this is too dense to ride through on horseback. It constitutes a favorite cover for deer, and as a soil retainer and gatherer is unsurpassed. Mixed with the shin oak is small live oak, mountain oak, hackberry,

black haw, plum, sumach, and holly, and much thorny smilax, grapevine, and other climbers.

In addition to these types of mixed forest, which are distinguished from one another by differences in density and growth rather than in make-up, there are three very different types, two of which are characteristically pure, while in the third two species of oak dominate the mixture. These are mountain oak thickets, cedar brakes, and post oak timber.

Mountain oak thickets.—The mountain oak, also called Spanish oak (*Quercus schneckii*, a mountain form of *Quercus texana*), makes a tall, symmetrical, and rather rapid growth. Its timber is valuable for fuel and for some other purposes. On slopes of low gradient (formed especially by harder limestone which splits into large blocks), on the sides of gorges cut in this harder limestone, and on the flat tops of buttes this mountain oak establishes itself in dense thickets, and soon makes a most effective covering and protection (Pl. II, fig. 2). Beneath it debris collects rapidly. Its close stand, its uniform, symmetrical growth, and its fresh, green, finely cut foliage give it a beauty possessed by no other forest type of the region—a beauty which is enhanced when, with the coming of November frost, the foliage assumes the richer hues of red and orange, quite unlike the gradual somber browning of most deciduous foliage in this climate.

Mountain oak is most eagerly bought for fuel; the tree sprouts up quickly from the stump and is easily renewed. It ought to be more generally established in this region.

Cedar brakes.—The writer knows of no region in which any species of cedar is so uniformly abundant and dominant as is the mountain cedar in the limestone country of Texas. By any structural characteristic it is difficult to distinguish this tree from the red cedar of the Atlantic States, yet in its natural occurrence it does not suggest the red cedar at all. While the red cedar is associated largely with bottomlands, and even with swampy bottoms, the mountain cedar is one of the most pronounced and hardy xerophytic trees of all the arid Southwest. It is, in fact, one of the most valuable assets of the region, as well as the most characteristic feature of the hill timber. It is most conspicuous on the white, arid hills of crumbly limestone, because it is there the dominant and practically the only species (Pl. I, fig. 1; Pl. III, fig. 2). But it also grows in mixture with other species, and attains its largest growth in the mixed forest of lower flats already described, where there is more water and richer, deeper soil. In such situations the best yield of poles and ties is found. Reasonably clear poles 20 to 30 feet in length and with a base diameter of from $1\frac{1}{2}$ to 2 feet were formerly common.

The typical cedar brake is an almost impenetrable growth, the interlocking branches of the close-set trees persisting to the very ground

(Pl. III, fig. 1). It is true that some natural pruning occurs, but the intense light of this climate is little checked by cedar foliage, and so the undermost branches are not starved as they would be with a shadier foliage or in a climate of greater humidity and less intense illumination. There is no such thing therefore as a mountain cedar pole free from knots.

Although we have no very definite information as to the total area originally covered by commercial cedar or the amount still available, it is tolerably certain that the ground actually covered by the species, including what is being reforested or newly occupied, has not been greatly diminished. Cedar land is not of much value for farming purposes, and tends after clearing to be rapidly regained by young growth (Pl. IV, fig. 1). It would appear, however, that there are some noteworthy exceptions to this. For example, instances are cited from Bell County where cedar clearings were captured by mountain oak, and a very capable observer in Kerr County writes:

When the brakes are once burnt out they never recover, but very soon grow up with different kinds of brush. * * * Some of my own cedar was burned about five years ago, and the ground is now covered with shin oak and Spanish oak sprouts.

The writer's observations as to the behavior of cedar on cleared lands on the Colorado would seem to justify the statement that it tends to regain ground formerly occupied by it, as well as that cleared of oak and mixed timber, and that in many cases it is rapidly spreading over slopes hitherto wholly free from timber. (See Pl. IV, fig. 1.)

In general, cedar timber occurs upon all of the hilly or rough parts of the limestone region of Texas from the Palo Pinto country to the Colorado, and thence westward over all of the drainage breaks and the escarpment nearly to the eastern forks of Devils River. The most extensive bodies of cedar known to the writer are those of the Colorado River breaks from Austin to the San Saba country. Mr. Howard Lacey (whose opinion has just been quoted in connection with cedar reforestation) says:

There is a vast quantity of cedar on the upper waters of the Frio, Nueces, Llano, Guadalupe, and Medina rivers. The scattered brakes begin a little way this side [west] of San Antonio, are at their best on the heads of the rivers named, and apparently play out about the heads of Devils River.

The post oak timber.—In a previous paper (Bulletin 47, U. S. Bureau of Forestry) the writer attempted to describe this type of forest and to give its geographical distribution in Texas. It is not a timber of limestone formation at all, but of sand and gravel-covered areas, such as the east Texas Lignitic Belt, the Cross Timbers, the Carboniferous area in central and north Texas, and the granite gravels and sandstone débris of the granite area. Smaller patches of this timber occur also on old gravel terraces, as in the vicinity of Austin.

Black jack and post oak constitute the chief elements in this type of timber, the post oak forming the more abundant and larger growth. The largest bodies of this timber of significance for our present discussion are those of the granite country. From Marble Falls to Llano the post oak timber is more or less continuous, generally forming an open, park-like growth, but sometimes a thick forest covering, as in the vicinity of Granite Mountain. On the rich and moister sandy loam near Fredericksburg is heavy post oak timber of large size, with a dense undergrowth and a larger percentage of other hardwood trees than is usual on the more arid gravel beds.

COMMERCIAL VALUE OF THE HILL TIMBER.

This phase of the subject is of importance for our consideration, since it affects the treatment of timbered tracts, and consequently their relation to water supply.

With the exception of cedar, the hill timber finds a market chiefly as fuel, of which enormous quantities are consumed, both in stoves and grates and in the furnaces of lime and brick kilns, gin engines, etc. Cedar likewise is extensively consumed as fuel and in charcoal burning; but its great value lies in its yield of railway ties, poles, posts, sills, and innumerable other articles which utilize its great durability.

A large part of the support of the hill country population comes from the sale of wood for fuel. Especially during those parts of the year when the cultivation and harvest of meager crops does not claim their time, woodcutting is a prominent industry and an essential resource wherever markets or shipping points are within teaming distance.

Cedar is handled at all points within hauling distance of brakes; but cedar timber large enough to furnish ties and poles is becoming scarce, except in remote districts. Much is still handled at Marble Falls, Kerrville, Boerne, and other points not specifically known to the writer. Locally, cedar furnishes construction material for every possible demand, as for rail fences, slat or picket fences, fence posts, house sills, supports, and joists; so that, altogether, available supplies are constantly drawn upon, often to their temporary exhaustion and to the great detriment of the denuded hillsides.

AGENCIES WHICH TEND TO REDUCE THE TIMBERED AREA.

CLEARING FOR FARM LANDS.

It was to be expected that most of the timber on the rich bottomlands would be cleared off in order to bring the land into cultivation. This sacrifice of the timber seems, on the whole, to have been advisable and profitable. A considerable amount of level uplands has also been

cleared. Where the soil was deep enough and rich enough to make cultivation continuously profitable, this was the best use to make of the land. The cases in which injury has been done are those in which timber has been cleared from thin-soiled, stony slopes in order to cultivate in a slovenly fashion for a few seasons, after which the land is worn out and abandoned. These clearings constitute the little cotton patches or cane and truck patches of mountaineers.

THE DEMAND FOR FUEL, POSTS, TIES, AND OTHER CLASSES OF TIMBER.

We have seen that the commercial value of the timber, particularly of the cedar, results in a heavy drain on the supplies. So long as small owners depend in large measure for their income upon the sale of wood, the temptation will be strong to denude rough, thin-soiled hillsides which would far better be kept with a protective timber covering. (Pl. II, fig. 2). While it is not to be expected that the private owner will ever wish to maintain a protective forest cover in behalf of the community at the sacrifice of personal profit, there is nevertheless room to hope that private owners will eventually find they can make more in the long run if they cut conservatively. Under the pressure of public sentiment and with the guidance of a practical object lesson, these timber owners may find it possible both to sell the merchantable timber and at the same time to maintain a protective covering for the hills. In this, fortunately, they will be assisted by the natural tendency of this forest to reoccupy lost ground.

CEDAR BRAKE FIRES.

There are few types of forest which more invite destruction by fire than the cedar brakes of dry central Texas. It is probable that during the past twenty-five years far more cedar timber has been burned than has been marketed, and vastly greater areas denuded by fire than by the axe. A cedar brake during the dry season is almost as likely a mark for fire as a prairie covered by tall dry grass. The evidence of fires recent or ancient is always near at hand. Some hillside has been swept bare, or a whole succession of formerly cedar-covered hills has been denuded of timber. The writer has not attempted to collect information about cedar brake fires methodically, but conversation with old residents reveals the fact that each community has had its fires.

The most destructive fire reported in several years was that which raged for over two days near Marble Falls, in July, 1901. The following extract from a correspondent's statement in the Austin Statesman of July 7 will indicate the local interest:

Intelligence has just reached here to the effect that a great deal of valuable cedar land in the immediate vicinity of Marble Falls has been destroyed by fire. * * * The conflagration has been burning since Friday. * * * The residents have made heroic efforts to block the course of the fire, but so far they have not succeeded. * * * Of course a great many people living there are interested in those

timberlands. * * * For a time the place fairly went wild, and everyone seemed to be in a frenzy of excitement. Up to the time when I left nothing definite had been learned, although it was known that many thousands of dollars' worth of cedar had been consumed.

ENCROACHMENT OF TIMBER GROWTH UPON THE EDWARDS PLATEAU.

In previous paragraphs there has been occasion to mention the energy with which the timber tends not only to renew itself on ground previously occupied, but also to gain upon the untimbered slopes and even upon the grass prairie. It was pointed out as a striking phenomenon that the region is in reality in a gradual process of transition from open prairie to forest land. This phenomenon is by no means peculiar to the Edwards Plateau. The Rio Grande Plain strikingly illustrates it. In that region the mesquite and chaparral have captured hundreds, perhaps thousands, of square miles of open prairie.

ENERGY AND RAPIDITY WITH WHICH LANDS ARE REFORESTED.

Specific data concerning the growth rate of the various species of trees in the climate of central and western Texas are not at hand. Naturally, however, under the semiarid conditions prevailing on the hills, this rate is slow, and the timber is characteristically hard and stunted.

Renewal is partly from young timber left on the ground, partly from seedlings, and in a considerable degree from coppice growth or sprouting from the stump. This latter method is especially characteristic of oaks. Mr. Lacey's statement that five years after a cedar-brake fire on his land in Kerr County the ground was covered with shin oak and Spanish oak sprouts has already been quoted. Some hillsides near Austin from which the timber was cut five years ago are now fairly covered with young growth. On numerous clearings in the same neighborhood seedling cedar occurs in thickets. Indeed, this hardy tree appears to be the most strenuous ground-gainer of all. The most striking instance known to the writer of its capacity in this respect is afforded by a tract on Dry Creek, near Austin, from which the timber was cleared twenty-five years ago. During the past two or three years this tract has again been cut, with a large yield of fuel timber. Fig. 1 of Pl. IV shows the condition of the cedar brake after twenty-five years' growth. Of course there was very little, if any, tie or post timber in this, and no clear heart cedar. Mention was made earlier in this paper of the prompt and rapid reforestation of denuded cedar brakes by mountain oak in Bell County. These instances suffice to show that the forest type of the limestone country is very strenuous in maintaining its ground.

HOW SCRUB OAK TIMBER GAINS ON THE UPLAND PRAIRIES AND DIVIDES.

Though the encroachment of timber on the prairie is gradual and insidious, to those whose observation covers a space of twenty-five years the change is truly startling. Where at the beginning of that period the prairie held undisputed sway, the observer now finds himself shut in by miles of oak scrub on every side. Men who drove cattle in the earlier days say that they rode across an open country from above Georgetown to the Colorado breaks, in Williamson County. This same region is now all heavily timbered. A great deal of the shinnery country undoubtedly represents a recent gain of timber growth on prairie divides.

This struggle of the timberlands to capture the grass lands is an old warfare. For years the grass, unweakened by overgrazing of stock, and with the fire for an ally, held victorious possession. Now the timber has the advantage. It spreads like infection. From the edge of the brush each year new sprouts or seedlings are pushed out a few feet farther, or, under the protection of some isolated live oak or accidental briar or shrub, a seedling gets its start, and presently offers shelter for others. This has been going on all along, but in former days these members of the vanguard and the scattered skirmishers were killed by the prairie fires, and the timber front was held in check or driven back into the hills.

HOW CEDAR CAPTURES ADOBE SLOPES.

It will be recalled that some of the limestones of this region break up on exposure into a crumbly *débris*, ranging from cobblestone size to adobe clay. Slopes occupied by this *débris* are long and gradual, except where harder strata alternate. On account of the unstable and arid nature of the formation, vegetation is commonly too scanty to hide the white glare of the limestone.

The mountain cedar has shown its capacity to establish itself upon such slopes in advance of every other species of timber, and almost of every other plant. Pl. III, fig. 2, shows the cedar on a steep slope where harder limestones intervene. This furnishes a particularly picturesque and parklike view, to which the photograph has by no means done justice. There is a beautiful gradation in size of these symmetrical young trees, from the youngest bushes toward the flats to the old trees which cap the summit of the buttes, from whence the invasion began.

THE SPREAD OF MESQUITE AND CHAPARRAL.

By no means the least striking phenomenon in this campaign of encroachment of timber upon prairie land has been the spread of the mesquite over the cattle country. Mesquite is essentially an occupant of flat prairie lands; hence its extension in the hill country proper is

limited. But throughout the area of the Edwards Plateau it has established itself upon pastures, often covering these with a thicket as close as that of the scrub oak. More commonly, however, the mesquite forms an open, orchard-like growth, into which finally enter various shrubs, or chaparral species, with very commonly the prickly pear and the slender round-stemmed *Opuntia*. The final result of mesquite encroachment is a heavy covering of vegetation, which, however well it might serve as a protector of water supply and soils, is to be regarded as an incubus upon lands which would be vastly more profitable under cultivation or under a good grass cover.^a

The capturing of pasture lands by mesquite is shown in Pl. IV, fig. 2.

HOW THE TIMBER GETS STARTED ON STEEP, ROCKY HILLSIDES.

The characteristic way in which some types of limestone formation have been eroded leaves them so steep and bare of soil that timber trees can find no anchorage. Even the cedar is for the most part absent; but more likely because there is so little opportunity for seeding than because of lack of adaptability to the location. The writer has observed that certain shrubs, especially a southwestern sumach (*Rhus virens*), find lodgment at the base of the low ledges of the harder limestone strata, and, spreading thence, form a protection for other species which slowly come to occupy the difficult location.

INFLUENCE OF THE EDWARDS PLATEAU TIMBER UPON CLIMATE, SOIL, AND WATER SUPPLY.

The foregoing pages have described the importance and character of the water supply derived from the Edwards Plateau, and the timber growth found upon it. It remains to consider the relation of this timber growth to the water-yielding capacity of the region, with a view to discovering what practical conclusions can be drawn as to how to secure the best usefulness of the forests.

INFLUENCE OF THE TIMBER GROWTH UPON CLIMATE.

Although the general subject of the influence of forests upon climate has been for many years under careful investigation, final conclusions have not yet been reached. The widespread belief that forest destruction on a large scale brings after it marked climatic changes rests on no scientific proof, and is undoubtedly in part at least the result of a misinterpretation of certain broad facts. That flourishing forests and a moist climate go together, while the nearer the approach to arid conditions the sparser and poorer does the tree growth become,

^aOn many square miles of the Rio Grande Plain the mesquite has already become a thicket, harboring the prickly pear and shrubby growth to the great detriment of the cattle ranges. In spite of this the mesquite must be looked upon as a prolific source of fuel, and to a less extent of construction material.



FIG. 1.—CEDAR BRAKE NEAR AUSTIN TWENTY-FIVE YEARS AFTER FIRST CUTTING.
A heavy crop of fuel and charcoal. Shows capacity for reforestation.



FIG. 2.—CHARACTERISTIC ENCROACHMENT OF MESQUITE ON PASTURE LAND IN CENTRAL TEXAS.

With the exception of a few scattered live oaks this was a clean prairie a few years ago.



FIG. 1.—“SOUTH GORGE” AT ITS HEAD UNDER LONE TREE HILL, NEAR AUSTIN.
The slopes have been denuded of timber. The run-off water after heavy rainfall is very violent.



FIG. 2.—“NORTH GORGE” FROM LONE TREE HILL.
Heavily timbered slopes. Violence of rainfall broken and rapid run-off prevented.

is known to everyone. It is also a matter of common observation that forest denudation is followed by marked changes in the character of stream flow and in the permanency of springs. Forests also protect from drying winds and sunshine, and tend to maintain a higher water-level in the soil. A natural but mistaken inference from these facts is that an absence of forests makes a dry climate. It may be that forest removal over large areas does appreciably lessen precipitation, though conclusive evidence of this has never been secured, but a sufficient explanation of all that has just been said is found in the undoubted truths that a moist climate favors forest growth, and that forests economize the rainfall by retarding evaporation and equalizing distribution.

Bearing these facts in mind as a preliminary caution against drawing too wide conclusions from what may be said, it is possible to set forth certain ways in which the forests of this region may exercise more or less influence on the climate. How important this influence may be is another matter. The climatic features likely to be chiefly affected are temperature and humidity. To discover by observation within the region itself to what degree forest growth does actually influence these would be exceedingly difficult, if not impossible; especially in view of the marked instability of weather conditions as well as wide variations within short distances which, as already remarked, characterize this transitional zone. Such facts can be established anywhere only after the most careful and long-continued meteorological observations and measurements. Some general principles, however, are now commonly accepted by students of forest problems, and by fitting these to the conditions which we know to exist in the Edwards Plateau region certain deductions may fairly be made. But the method thus employed is, so far as the particular locality is concerned, theoretical, not experimental, and at best can lead only to very indefinite conclusions as to the actual extent of the influence on climate which it is possible to ascribe to the forests of the plateau.

INFLUENCE UPON TEMPERATURE.

In the first place, the forest cover furnishes a canopy against the sun's rays, which, with the accumulated soil and *débris* incident to forest growth, prevents intense heating of the rocks. The burning sensation of the reflected midday heat is vividly present to those who have toiled on horseback or in a stage over the stony wastes of the Devils River and Pecos countries during midsummer. Here an endless stretch of bare limestone is exposed to the most intense sunlight, until the air feels like the blast from a furnace. The transpiration of water vapor which is constantly going on from the leaf surface of a forest also operates to reduce the temperature to some degree, just as drinking water is commonly cooled in this dry air by suspending it in the

breeze in an open pail or in a porous earthen vessel. Over against this, however, must be set the fact that the transpiration from heavy grass is still greater than that from a forest. But in those regions which are too arid to support more than a scanty vegetation of other than forest growth, the presence of timber would doubtless conduce to some mitigation of the intense heat, and would also tend to increase the moisture in the air through evaporation from the leaves.

INFLUENCE UPON SOIL AND WATER SUPPLY.

One of the most important services of a forest cover is the mechanical effect which it exercises upon falling rain and upon the run-off. In this way it both checks erosion and promotes the entrance of water into the earth. In the first place, the crowns of the trees, especially when the foliage is on, break the force of the rain and cause it to run harmlessly down the trunk, or to drip slowly through the canopy. Further, the organic *débris* of the forest floor holds back the fallen water until it has time to soak into the soil. The spreading and interlacing network of roots serves the same purpose, and binds the soil fast against erosion. Thus the rain is kept from swift discharge into the streams, gulying is prevented, and the run-off does not gain sudden volume and velocity after a downpour. The removal of timber from broken or mountainous areas is pretty sure to be followed by more frequent and destructive floods.

A forest also increases the water supply from a region by increasing the moisture-holding capacity of the soil. The undecomposed litter which forms the upper layer of the forest floor will itself take up much water, as well as delay its run-off. A thick mat of leaves will be wet at a little distance down long after those on top have become thoroughly dry. Still lower, the half-decayed rubbish is like a sponge in its water-holding power. And finally, the humus, or forest soil proper, with its loose texture and large proportion of organic matter, is peculiarly fitted to delay percolation. Thus the forest builds up a storage reservoir, the loss of which often makes necessary the construction on a large scale of artificial lakes to conserve the water supply. This work the forest does not only without expense, but while itself growing wood.

Not only does the forest store water in the soil, but it also prevents its loss by evaporation. The trees themselves shield the ground from the sun, and check the movement of drying winds. They also keep the soil cool, and in consequence lessen the giving off of moisture. This defense against evaporation is further reenforced by the undergrowth and the leaf litter, while the forest soil itself acts as a mulch to prevent drying out. We have seen that the dry air of the Edwards Plateau region is capable of removing by evaporation over 50 inches of free water in the course of a year. When rain falls on the bare

earth, therefore, the thirsty air soon takes most of it up again, rapidly drying out the earth to a depth fatal to any but very deep-rooted plants. More extreme is this drying out when the surface is covered by loose stones, as is the case with most of the limestone country, especially west of the timber belt. It is true that a forest evaporates much water from the foliage, but it draws this largely from the lower soil levels; so that, even if the total loss of water from a forest area were equal to that on an exposed area, the earth would not be baked so dry, nor would shallow-rooted herbaceous vegetation be so effectually excluded.

Pl. II, fig. 1, illustrates the value of heavy timber covering in this direction. The canopy of foliage itself is heavy. Beneath, there has been an accumulation of organic débris to the depth of from 8 to 15 inches, the lower layers of which are decomposed into pure humus soil. In such places flourish moisture-loving plants which are altogether wanting on similarly situated naked slopes. (See Pl. V.)

For all these reasons forests tend to conserve the water supply and to maintain full springs and an even flow of streams.

ILLUSTRATIONS OF THE EFFECTS OF THE EDWARDS PLATEAU FOREST.

- Conditions in the vicinity of Austin furnish an unexcelled opportunity to observe both the effect of heavy timber upon the behavior of precipitated water and the results of rainfall on bare slopes. Beginning at the site of the old Austin dam, there is a series of deep gorges which extend for 10 miles up the river, and head in the high hills of the divide between the Colorado and Barton Creek. Two such gorges lead down from Lone Tree Hill (Pl. V, figs. 1 and 2). The head of each gorge spreads out in slopes which lead upward to the summits of the hills like an amphitheater, and, by their convergence below, act as a funnel to direct the water into the channel of the stream. The slopes of the southernmost of these gorges, though well timbered below, have been almost denuded farther back, especially over the part likened to an amphitheater (Pl. V, fig. 1). The northernmost gorge is heavily timbered throughout (Pl. V, fig. 2). The slopes of the southern gorge are denuded of soil down to the rock and adobe, and are never covered with more than a scanty growth of drought-enduring plants, which do not suffice to hide the white, arid slopes. The channel of this gorge is swept clear of organic débris and even of the finer rock débris, leaving a rough, stony channel.

On the slopes of the northern gorge, under an almost impenetrable growth of cedar and mixed timber, there has accumulated a deep layer of rich soil covered by an unreduced débris of fallen leaves and twigs. Loose stones, which even a moderate flood would sweep downward, lie on the slopes, as well as the loose leaf litter—striking evidence of the difference in conditions between this and the southern gorge.

At the bottom of the gorge the timber growth still continues, almost blocking the channel, which, instead of being swept clear by flood water, is filled with forest litter and fine mineral sediment.

What happens in these two cases after a heavy rainfall? In the south gorge the water at once begins to pour down as from a steep roof, converging into swift streamlets which erode every vestige of organic soil, and in addition the adobe and smaller stones, which it often piles in heaps below. Uniting at the main channel, these flood waters pour down with the characteristics of a mountain torrent. In the north gorge, on the contrary, the downpour, particularly during the season when foliage is on (which is also the season of heaviest rains), broken by the timber covering, is shorn of its force, and, instead of packing the soil and débris and then running off, is largely taken up by the porous ground. Thus the water is prevented from getting head enough to form a flood or to erode the soil, and at the same time is detained so that vastly greater quantities are absorbed by the limestone formation beneath.

In the case of some of the gorges farther up the river, e. g., Devils Gorge, the upper slopes are bare; but farther down there begins a heavy growth of mountain oak or mixed timber, which extends to the bottom of the gorge. Beneath this is a rich soil, covered by a foot or more of looser organic débris, which disorganizes slowly because so persistently dried out, but which retains moisture beneath and is all the more active in absorbing the rainfall. In spite of the velocity gained by the water on the upper slopes, its progress is so checked by the vegetation and débris below that only after an unusual downpour does the channel flood attain violence.

It is unusual for any of these short gorges to maintain running streams throughout the season. Ordinarily they are entirely dry before midsummer. In those gorges whose slopes are denuded, the flow ceases almost directly after each fall of rain. But there is one gorge which furnishes a very instructive object lesson of a different character. It is some 12 miles up the river from Austin, and is heavily timbered. During the spring of 1903 this gorge became a favorite resort because of its natural wooded beauty, and especially because of its series of cascades and deep, clear pools. It had all the appearance of a mountain stream of the humid Eastern States. The streams which feed the streamlet appear to be gravity springs, from which flows water which has fallen upon the local catchment area.

Naturally, their flow reflects the season's rainfall. The upper spring, at least, dries up with the advance of the dry season, and the flow from the main lower one becomes very meager. Nevertheless, these springs were still flowing freely long after the streams in all the other gorges had been completely dry. This difference seems to be due to the two facts that, in the first place, the local catchment area

(the slopes feeding the gorge) is larger than the others, and, secondly, that the slopes and bottom of the gorge are densely timbered and possess a heavy covering of löamy débris beneath.

Let us suppose that what is true for the small area just described were true in the case of the whole plateau region. The effects as to checking floods, collecting soil, preventing erosion, promoting the entrance of water into the earth, and maintaining a longer and more constant flow of springs and streams would be multiplied many thousandfold. That would be a fact of vast significance for this region in its relation to the activities of human life within it, and still more to those of the rich plain on its coastward side.

This enforces the fact that from the point of view of water supply the Edwards Plateau is to be regarded as sustaining the same sort of relation, if not in the same degree, to the Rio Grande Plain that the Sierras do to the San Joaquin Valley, the Wasatch Mountains to the irrigable lands about the Great Salt Lake basin, and the Rocky Mountains to the high plains in Colorado.

THE PROBLEM OF MAINTAINING A FOREST COVER ON THE HILLY COUNTRY OF THE EDWARDS PLATEAU.

The problem of dealing with such a region as the Edwards Plateau scarcely falls within the scope of individual enterprise, although if cooperation between private owners and the State could be brought about, it would result in mutual gain. The rice planter on the coast wants the most constant flow possible in the Colorado, Guadalupe, San Antonio, and other rivers. Ranchmen on the inner border of the coast plain want the largest possible flow of artesian water. The hill ranchmen want their soils preserved and built up and the level of soil moisture kept near enough to the surface to be available for crops. All desire to see destructive floods prevented; all want this water held back to be given out so as to be utilized. All these classes of citizens would be gainers if the rough country were kept fully timbered and the dry plains covered with heavy grass. At the last it will rest with cattlemen of the plains and with ranchmen of the hills whether their pastures are worn out by overgrazing and their hills denuded by unwise cutting. In the long run, these men will find that they can both pasture the plains and market the timber without destroying the protective value of a grass cover on the one hand or of a timber cover on the other. Meanwhile the rough breaks of the margin of the plains, which are not especially valuable for pastures, and certainly of no value for farming, offer a task the performance of which, in the writer's opinion, may be undertaken only by the State itself. Considering all the interests dependent upon the water supply of this region, there would seem to be little ground for opposing the policy of maintaining (and where necessary establishing) a forest cover upon these arid

hills. Cooperation with individual owners fails to meet the needs here. Nothing short of absolute ownership and management by the State will suffice.

In Bulletin 47 of the Bureau of Forestry the writer has discussed more fully the question of the relation of the State of Texas to its forests. Without repeating what was said there, it may be remarked that the present is a rather auspicious time and the water supply of the Edwards Plateau a practical opportunity for the State to enter upon a policy of forest management in the interests of its people. We may, in conclusion, refer to the possibilities of water storage in canyon reservoirs on the margin of the plateau overlooking the Coast Plain as a field for further activity by the State, analogous to the recently adopted comprehensive irrigation policy of the National Government.





TYPICAL LONGLEAF PINE (*PINUS PALUSTRIS*) OF THE TEXAS-LOUISIANA REGION.

2
U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY—BULLETIN No. 47.
GIFFORD PINCHOT, Forester.

FOREST RESOURCES OF TEXAS.

BY

WILLIAM L. BRAY,
COLLABORATOR, BUREAU OF FORESTRY.



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1904.

LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY,

Washington, D. C., June 29, 1903.

SIR: I have the honor to transmit herewith a report entitled "Forest Resources of Texas," by William L. Bray, collaborator in the Bureau of Forestry, and to recommend its publication as Bulletin No. 47 of the Bureau of Forestry.

The eight plates, two text figures, and three maps accompanying this report are necessary for its proper illustration.

Very respectfully,

GIFFORD PINCHOT, *Forester.*

Hon. JAMES WILSON,
Secretary of Agriculture.

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FOREST RESOURCES OF TEXAS.

THE FOREST.

NATURAL CONDITIONS AFFECTING THE CHARACTER AND DISTRIBUTION OF FOREST GROWTH IN TEXAS.

Within the State of Texas the natural conditions on which depend the range and make-up of the forest are of the most diverse character. In geographical position, its southernmost point lies almost in the edge of the Tropics, while its far northern portions are within the wheat and corn belt of the Middle Western States. Its climate varies from the even warmth of the coast lowlands, tempered by the ameliorating influences of the Gulf, to the rigors and extremes of the mountainous interior, and from the heavy rainfall and moisture-laden air of the east to the arid conditions of the western desert, with its dry, burning winds. In relief, the State rises from the sea level by diversified terraces to high plains 4,000 or 5,000 feet above the Gulf, and then to rugged mountains of the continental axis, which attain an elevation of nearly 10,000 feet. This vast terraced area has been further diversified by extensive erosion, which has carved and transported and built up again. The geological structure has resulted in the formation of soils of such divergent types as the alluvial bottomlands of the Gulf coast, the waxy loams of the prairies, and the wooded highlands and broken masses of the Plateau and Cordilleran Region. Corresponding to these differences in environment, the State presents a variety of forest types which passes from the swamp and bayou forest of east Texas, essentially the same with that of the States which border the lower Mississippi, through the great timber territory of the longleaf pine on the south, and to the north the no less extensive, though less valuable, region of the post oak, to the chaparral and mesquite of the Rio Grande Plain, and to the stunted bull pine and red fir of the summits and high canyons of the extreme west.

NATURAL DIVISIONS OF THE STATE.

The divisions of the State which are of significance for a discussion of forest growth are physiographic rather than geological. (See fig.

1.) They are the following:

1. The Coast Plain.
2. The Fayette Prairie.
3. The Lignitic Belt.
4. The Rio Grande Plain.
5. The Black Prairie, Grand Prairie, and Edwards Plateau.
6. The Central Denuded Region.
7. The Red Beds Prairies.
8. The Staked Plains.
9. The Stockton Plateau.
10. The Cordilleran Region.

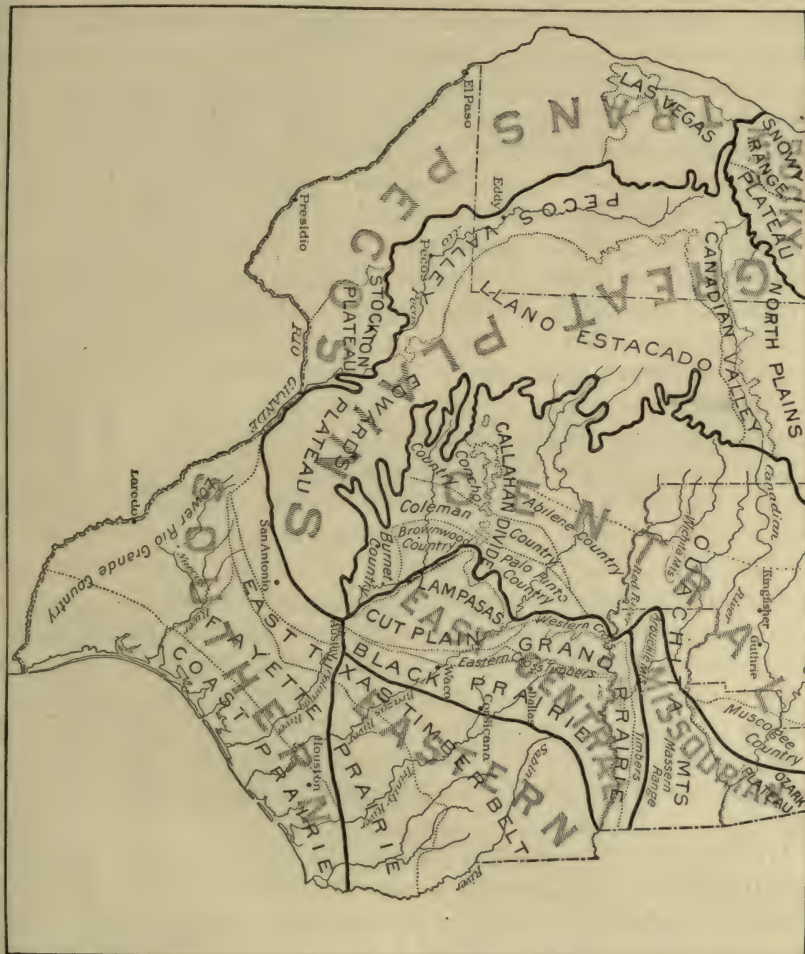
(1) The Coast Plain, over 15,000 square miles in extent, is the low, flat plain lying along the Gulf, from which it has emerged in very recent geological time. It comprises a strip 50 miles in width, more or less, parallel to the Gulf and scarcely exceeding 50 feet in altitude at any point. The rainfall exceeds 50 inches at the east, but decreases to 30 inches soon after passing the ninety-seventh meridian. The Coast Plain from $97^{\circ} 30'$ westward may be arbitrarily included with the Rio Grande Plain. The soils of the Coast Plain, thus limited, consist of compact clays and silts, interspersed with areas having a larger proportion of sand, and therefore more porous soils. These latter are more easily captured by forest, the compact soils more slowly. Thus one finds alternating areas of forest and prairie. Where streamways cut across the Coast Plain a line of timber follows to the Gulf.

(2) The Fayette Prairie, containing 12,000 square miles, is a narrower belt of more uneven, undulating country, lying next inland and parallel to the Coast Plain. The rainfall conditions of the Coast Plain are repeated here; but the disposition of the water is different, owing to the deep beds of sandy clays and gravels which characterize the belt. The soil structure is especially favorable to timber growth. The Fayette Prairie east of the Trinity is occupied by longleaf forest. West of this the timber is mainly post oak, black jack, and live oak. These extend to the Nueces River, or farther; but the Fayette Prairie west of $97^{\circ} 30'$ will be classed as Rio Grande Plain.

(3) The Lignitic Belt, over 30,000 square miles in area, is an older geological formation (Marine Eocene), lying next inland from the Fayette Prairie. The altitude is greater, ranging from 200 to 500 feet, and erosion has left a much more uneven country than that of the two preceding divisions. Counting that portion west of $97^{\circ} 30'$ as Rio Grande Plain, the remainder comprises a large area of sandy clay ridges and hills, occupying all of east Texas interior to the Fayette

Prairie. The inner boundary runs approximately from Seguin (an arbitrary western limit) through Elgin, Cameron, Corsicana, and Sulphur Springs to the Red River. The open soil structure and heavy rainfall—especially eastward—make this a natural forest area, and in fact it is covered by the southwestward continuation of the Atlantic Forest Belt.

FIG. 1.—Provinces and minor subdivisions of the Greater Texas region. (From Hill's Phys. Geog. of Texas.)



(4) The Rio Grande Plain, of over 20,000 square miles, in a narrow sense would include only the Rio Grande embayment,^a but as here employed includes the western portions of the three preceding divisions, from about $97^{\circ} 30'$ to the Rio Grande. Its interior boundary is the escarpment of the Great Plains Region, whose southern province is the Edwards Plateau. The soils of the Rio Grande Plain are largely

^a Hill, Physical Geography of the Texas Region, p. 2.

favorable for timber growth, but the low rainfall precludes the possibility of luxuriant forest. The woody vegetation consists of the characteristic chaparral, which is of arborescent height in the better watered parts, but becomes reduced to dwarfed shrubbery in the most arid areas.

(5) Next in series inland lies the vast Cretaceous Belt including the Black and Grand prairies and the Edwards Plateau, an area of some 40,000 square miles. The Black and Grand prairies are typical grass prairie country, possessing timber originally only on the bottoms and breaks of streamways and escarpment bluffs. Really the presence of these features, together with the intrusions of the two tongues of sand-bed country known as the Cross Timbers, brings a very considerable amount of timber within this typically prairie region. The rainfall would be sufficient to support rather heavy forest, particularly on the Black Prairies, but the very compact, waxy soil of these prairies and the impenetrable chalk beds of the Grand Prairie give grasses the advantage over woody vegetation in their struggle for the ground. The Edwards Plateau is very different. This is an area roughened by erosion, exposing the limestone strata to the reception of rainfall, which, though diminished to less than 30 inches, is still enough, under the physiographic conditions, to support a heavy though dwarfed timber covering. The Edwards Plateau embraces some 15,000 square miles from the southern province of the Great Plains Region. Toward the northwest the altitude increases to over 2,000 feet, and it merges at last into the Staked Plains. The southern border is very deeply dissected by erosion into a hilly, almost mountainous country, which is natural timberland.

(6) The Central Denuded Region is an area perhaps half as large as the Edwards Plateau, from which the Cretaceous strata have been eroded, exposing an area of granite at the south and of carboniferous sandstone at the north. Both are rough areas, with hills, bluffs, and gravelly flats or ridges favorable to timber growth. This is of post oak on gravelly ridges, of mountain cedar on hills, and of mesquite on flats.

(7) The Red Beds Prairies comprise an area approximating 10,000 square miles in north central Texas, abutting on the Staked Plains. Over this area the influence of altitude, distance westward and inland, and soils not especially pervious to water, leads to the complete predominance of grass vegetation except on streamways.

(8) The Staked Plains, with an area of 44,000 square miles, are, so far as soil conditions go, ideal for timber growth. The dryness of the region, however, does not permit timber growth of any kind except in canyons and on the escarpment bluffs. Where water is available, as about ranches, trees flourish to an unusual degree, and are hampered only by the severe winds.

(9) The Stockton Plateau is simply the continuation beyond the Pecos of the Cretaceous area of which the Edwards Plateau is a province. This is not a timbered country at all, except in canyons and on some rough breaks, where mountain cedar occurs. The arid climate and the compact adobe soils or rocky, debris-covered slopes are too unfavorable for timber growth. The Stockton Plateau extends to the eastern point of the Cordilleran Region.

(10) The Cordilleran Region comprises a vast area of over 30,000 square miles (including the Stockton Plateau), being part of the South Rocky Mountain Plateau. There are large tracts of high grass plains and scattered mountain masses, with intervening undrained pockets ("bolson flats"). The altitude in several instances is sufficient to increase the rainfall to nearly 20 inches, where the normal for that meridian is under 15. This and the fractured condition of the strata render these mountains capable of sustaining rather heavy timber of the Southern Rocky Mountains type. Especially noteworthy is the timber growth in the Guadalupe, Davis, and Chisos mountains.

CAUSES DETERMINING FOREST DISTRIBUTION IN TEXAS.

The principal natural influences which have determined the character and extent of forests in Texas are rainfall, nature of the soil and rock, temperature, sunlight, and winds. Of these the first two are by far the most important.

RAINFALL.

The rainfall of Texas decreases progressively from east to west. A map constructed to indicate the annual precipitation by 5-inch divisions would show a series of zones extending in a general north and south direction from the Sabine to the Pecos. Beyond the latter river the elevated mountain masses probably bring up the annual mean of rainfall, but at the westernmost boundary this average scarcely reaches 10 inches. (See fig. 2.) The limits of the several rainfall zones are approximately marked by the meridians of longitude. Thus, the ninety-fifth meridian about marks the western limit of rainfall exceeding 50 inches; the ninety-sixth, of 45 inches; the ninety-seventh, of 40 inches; and so on to the one hundred and second meridian, where the average annual rainfall has decreased to 15 inches.

Corresponding in a general way with these zones of rainfall, there is a series of zones of forests of different types. In the eastern region, having a rainfall in excess of 45 inches, are found the swamp and bayou forests of cypress, tupelo, water oak, swamp hickory, and other water-loving species; in slightly better drained localities, the black-gum, cottonwood, sycamore, beech, birch, and Spanish oak, and after them red oak, white oaks, walnut, pecan, magnolia, holly, and the

like. After these, on higher lands, come the pines, loblolly on the sandy knolls and ridges of the Coast Plain, longleaf on the more rolling sand barrens of the Fayette Prairie, and shortleaf on the higher uplands of the Lignitic Belt. The second forest zone consists of oak barrens, lying westward from the types of forest just mentioned, and in a rainfall zone of 45 to 35 inches. Next is the central Texas hill zone, with a rainfall of from over 30 to less than 25 inches, where occur mountain cedar, mountain oaks (five or six species), cedar elm, gum elastic, Mexican persimmon, and numerous others. Last of all come the pygmy forests of chaparral, embracing mesquite, retama, huisache, cat-claw, allthorn, palo-verde, and a score besides.

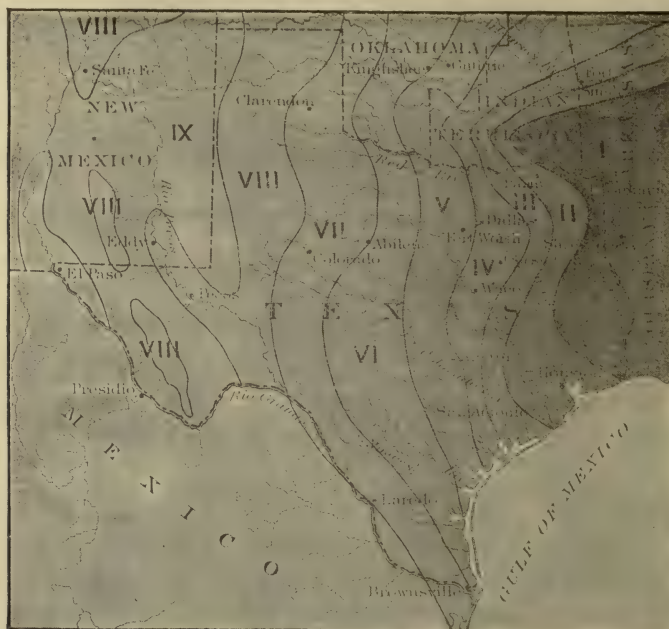


FIG. 2.—Precipitation in the Texas region: I, over 50 inches; II, over 45 inches; III, over 40 inches; IV, over 35 inches; V, over 30 inches; VI, over 25 inches; VII, over 20 inches; VIII, over 15 inches; IX, over 10 inches. More extended observations since the preparation of this map show a general slight reduction of the rainfall throughout this region.

Rainfall alone, however, does not determine the limits within which these species occur. There are canyons in the region where the annual rainfall is scarcely 20 inches in which may be found not only oaks, hickories, and similar trees, but even the swamp-loving cypress. While the moisture demands of the different kinds of trees constitute the most potent of the causes which determine their distribution, it is not primarily the amount of moisture which falls to the ground, but the amount of moisture which the soil holds that affects them. The distribution through the zones of rainfall is consequently modified very considerably by the varying geological and soil conditions.

NATURE OF THE SOIL AND ROCK.

The geological structure alone may account for heavy timber in regions of low rainfall, simply by the supply of percolating waters which it may furnish. The heavily timbered canyons of the Edwards Plateau as far west as Kerr County are an example of this. On the other hand, upon the pine barrens of east Texas, although the rainfall is heavy, the form and habit of growth of young longleaf pine shows very evidently its adaptation to periods when there is lack of sufficient moisture—a lack which the older trees partially overcome by sending their roots deep into the sand beds, through which the rain water drains away from the surface. In general, erosion canyons and the broken strata of mountain masses tend to make percolation waters available, and explain the relatively heavy timber in the far west of the State. So also the waxy clay soils of the Black Prairie, which tenaciously retain the moisture supplied by precipitation, support a forest growth which on more porous soils in the same rainfall area can not maintain itself. The swamp forests, the alluvial bottom forests, the loblolly and hardwood, and the shortleaf and hardwood forests are distinct forest types in a region of high rainfall, within which soil texture and chemical make up, configuration, and elevation are the determining factors. To understand the various types of forest which the State furnishes, it is necessary to take into consideration along with the rainfall the geological formation, the quality of the soil, and the physiographic features, which not only determine the minor classifications within each type, but also often broadly modify the types of large areas.

Nevertheless, it is rainfall rather than the nature of the soil and rock which has played the principal part in producing the main types into which the forests of the State naturally divide themselves. This is shown by the fact that the gradual transition from moisture-loving to drouth-enduring species takes place along the line of decreasing rainfall, and across the line of successive geological formations. These successive formations lie approximately parallel with the present Gulf coast, so that they traverse the rainfall zones nearly at right angles. It has already been pointed out that the forest belts follow a general north and south direction; in consequence they succeed one another along each geological formation. For example, the Fayette Prairie begins at the Sabine with very heavy forests of longleaf pine, which are succeeded west of the Trinity by post oak as the dominant species. As we advance southwestward this becomes more open and stunted, until at last it disappears in the dense body of the Rio Grande chaparral.

TEMPERATURE.

On the whole, the trees which compose the forests of Texas are those characteristically found in the southern part of the United States. The presence of palmetto, magnolia, live oak, longleaf and loblolly pine, and the mimosas attest this. On the other hand, not only do many species of the forests of the Middle States and even of the North Atlantic States occur, and indeed extend almost to the Gulf—such as hornbeam, ironwood, river birch, beech, and black walnut, with certain of the hickories, ashes, and oaks—but in the Guadalupe Mountains, where the State reaches its greatest altitude of 9,500 feet, there also appear the western yellow pine and red fir, species characteristic of the Pacific Northwest. Along these lines temperature is the dominant selecting agency.

SUNLIGHT.

The area of Texas presents extremes in the amount and intensity of sunshine which are reflected in the character of the forest growth. Thus, in the eastern forest area the most intense illumination is prevented by the blanket of moist atmosphere, and the duration of it is limited by the high percentage of partly or wholly cloudy days. In this area develop thick-crowned hardwood forests, having a heavy undergrowth of shade-loving species. In the Rio Grande country, on the contrary, the sun beats down with great intensity during the growing season, and its force is little weakened by the extremely dry air and the continuously unclouded sky. The trees which have been favored by this condition of light and dryness have a meager foliage, such as mesquite and the acacias, which hardly break at all the direct force of the sun's rays and give insufficient shelter to less intolerant, to say nothing of shade-loving, species. Except in moist canyons and on alluvial bottoms, the Texas region west of the ninety-seventh meridian is conspicuously wanting in shade-loving trees, and in fact in shade-loving vegetation of all kinds.

In contrast with the thick-crowned hardwood forests of east Texas are its characteristically open stands of longleaf pine, itself intolerant of shade, and entirely destitute of an undergrowth of shade-loving species.

WINDS.

The wind plays its rôle chiefly in hindering the encroachment of timber. Its power in this direction will be better appreciated when a more general attempt is made to start tree plantations on the open prairie. Orchardists in the Gulf region realize what the Gulf breeze is to contend against, and their orchards record the battle. In the coast region and on the Staked Plains the habitual direction and force

of the wind would have to be taken account of in choosing and grouping species for planting.

The periodical recurrence of Gulf hurricanes has had a profound effect on the history of forest extension and on the present aspect of the forest on the coast plain. For example, in the hurricane of 1875 a vast area of pine in Montgomery and San Jacinto counties was destroyed. Following the burning of the débris, a thicket of hardwood—especially scrub oak—appeared very generally, thus changing, at least for years, the type of the forest. In the hurricane of September 9, 1900, the loblolly pine and the white oak in the coast country west of the Trinity were blown down in enormous quantity, thus disturbing the forest equilibrium and consequently, for the present, the type. The most evident effect of these storms is written in the ragged, uneven growth of timber in much of the coast country. This is especially noteworthy on the lower Brazos and the San Bernard, and may easily account for the occurrence of an occasional veteran in a ragged forest of small trees and dense undergrowth.

CLASSIFICATION OF THE FOREST.

THE EAST TEXAS TIMBER BELT.

Formerly an unbroken forest of the same general character covered the great plain of the Atlantic and Gulf coasts, from Virginia through the Carolinas, Georgia, northern Florida, Alabama, Mississippi, Louisiana, and Arkansas to eastern Texas, and from the foothills and mountain slopes of the southern Appalachians to the sea. The common characteristics of this vast region, to which are due the general homogeneity of its forest, are abundant rainfall, low elevation, and warm temperature. Although the Coast Plain itself continues toward the Rio Grande, the further extension of this forest is checked near the Brazos River by the drier climate of the southwest. Here its vanguard is broken into straggling detachments, of which only the hardier push onward along the prairie streamways or up the deeper canyons of the hills. It is a striking phenomenon, this breaking up and gradual dwindling away of so vast and vigorous a forest. Not only in Texas, but far to the north, through the Indian Territory, Kansas, Nebraska, and the Dakotas, the same thing may be seen. Like a vast wave that has rolled in upon a level beach, the Atlantic forest breaks upon the dry plains—halting, creeping forward, thinning out, and finally disappearing, except where, along a river course, it pushes far inland.

This east Texas timber belt may be subdivided into the following types:

Swamp and bayou forests, chiefly in the Coast Plain.

Hardwood forests of alluvial bottoms.

The mixed loblolly and hardwood forest of the interior of the Coast Plain.

The longleaf forests of the Fayette Prairie.

The hardwood and shortleaf forests of the Lignitic Belt.

SWAMP AND BAYOU FORESTS.

These forests are of the same character as the weirdly picturesque water forests of the Coast Plain in Louisiana. Along the lower Neches and Sabine rivers, at Beaumont and Orange for example, the type is as fully developed as on the bayous of the lower Mississippi or on the Calcasieu, at Lake Charles, Louisiana. Along all of the streams of the coast lowlands east of the Trinity the forests show to a greater or less degree the characteristics of this type, which follows them into the interior wherever they are sluggish and accompanied by swamps and bayous, as in the case of the big cypress, in Marion County. On the east these forests extend northward into Arkansas and as far as southeastern Missouri.

MAKE-UP OF THE SWAMP AND BAYOU FOREST.

The more important trees which compose this type of forest are bald cypress, swamp tupelo, water oak, swamp hickory, sweet gum, water ash, swamp maple, sweet magnolia, and black gum. Under these flourishes an undergrowth of many species of small trees and shrubs.

While all of the trees of these water-loving species ascend in places to higher ground to contend in mixture with other species for possession, the forest type which is produced by the exclusive association of these trees is confined to swamp land and the low borders of sluggish streams, where the water level in the soil is practically at the surface the year round, and where, for at least a part of the time, the ground is actually inundated, so that the lower parts of the trunks are submerged. Certain peculiarities of structure, as the expansion of the base of the trunk, and in the case of the cypress, the characteristic knees, mark their adaptation to such an environment. The compact, impervious clay and silt soil of the flat coast lowlands combines with the lack of drainage to produce conditions favorable to this forest type.

The relative representation of species varies greatly on different areas. In one place tupelo gum is dominant, in another cypress, elsewhere again swamp hickory. Such differences, however, due to local conditions which happen to have been especially favorable to some one kind of tree, do not alter the general type of swamp and bayou forest, which within its own territory retains undisturbed possession, no matter what may be the result of the competition for place among its individual members.

1. *Shortleaf pine.*

Pinon pine (P. edulis), Rocky Mountain oaks (Quercus grisea and Q. emoryi), and cedars (Juniperus purphyllæa, J. flaccida, and J. monosperma).

3. *Loblolly pine.*3a. *Isolated bodies of loblolly pine on the Colorado River.*4. *Longleaf pine forest.*5. *Western yellow pine (P. ponderosa), Limber pine (P. flexilis), Red fir (Pseudotsuga taxifolia), and other Rocky Mountain species.*6a. *Post oak lands of the Lignite Belt.*6b. *Eastern "Cross Timbers."*6c. *Western "Cross Timbers" and post oak of the Carboniferous area.*6d. *Post oak of the Granite area.*7a. *Main body of Edwards Plateau timber.*7b. *Scattered bodies of Edwards Plateau type of timber on breaks and along stream bottoms.*8a. *Coast Plain belt of heavy live oak, which is rapidly spreading on prairie lands.*8b. *Prairie lands with scattered live oak.*

TIMBER OF TEXAS, OMITTING MESQUITE, CHAPARRAL,
ALLUVIAL BOTTOM HARDWOODS, AND SWAMP AND BAYOU FOREST.

COMMERCIAL VALUE OF THE SWAMP FOREST.

In the Coast Plain of Louisiana the abundance of cypress makes the swamp forests very valuable. In Texas the cypress is not plentiful enough to be of special consequence. There is a fringe of it on almost all of the lowland streams, and there are some minor cypress swamps, but the best of this timber has already been cut, and what is left can probably be marketed with profit only in connection with lumbering of other species or of the swamp forest as a whole. A large amount of tupelo and other timber is available for cheap lumber for boxes, crates, and similar articles, but the demand for it scarcely exists as yet. At present what utilization there is of timber from these trees, as of black gum, for example, is drawn not from the swamp forests, but from those of the alluvial bottom type.

Ultimately a part of the land now occupied by the swamp forests will probably be turned into rice farms. It lies in the rice belt, and is better adapted by the conditions of its water supply to the cultivation of this crop than many areas which are now being developed for the same purpose. The apparently unlimited supply of cheap fuel furnished by the recently discovered oil fields of the region may stimulate new industries which will furnish a market for the great amount of timber material contained in this forest type. Should such be the case, the way would be open for the utilization of the timber now standing, as an accompaniment to the reclamation of the swamps for agriculture.

HARDWOOD FORESTS OF ALLUVIAL BOTTOMS.

These forests flourish in the broad erosion channels which the streams of east Texas have worn inland from the low-lying coast plain, chiefly in the Lignitic area. Prof. R. T. Hill describes this area as follows:

The drainage basins, because of the readiness with which the unconsolidated structure yields to erosion, occupy a far greater area than the remnants of the ancient plains in which they are carved. The present level of the rather sluggish streams is from 100 to 200 feet beneath the divides. Their flood plains are wide and somewhat unstable. A few feet above these bottoms are the inevitable accompaniments of all the major streams of the southern cotton belt, known as second bottom, often a mile or more in width. * * * The flat divides and wide valleys characterize the whole extent of the region.^a

An example of such a river bottom is that of the Trinity. For at least 100 miles of its course from Liberty northward the heavily timbered valley would no doubt average 5 miles in width. This would mean 500 square miles of chiefly hardwood forest. Similar bottoms are found along the Red River, Sulphur, Sabine, Neches, and Attoyac, besides many more of less extent.

^a R. T. Hill, *Irrigation*, 1893, p. 64.

COMPOSITION OF THE FOREST.

Associated in this forest are nearly all the well-known valuable hard woods of the Atlantic States, many of them in great abundance and perfection. First in quantity, variety, and value stand the oaks. Among the white oaks are the cow oak, bur oak, overcup oak, and the common white oak; of the black oaks, red oak, Texas oak, willow oak, and water oak. Next in importance comes ash, with white ash probably first and green ash second. The hickories are represented by the sweet and bitter pecan, shagbark, and white hickory. There is an endless quantity of gum, comprising sweet and black gum and tupelo, and much cottonwood, sycamore, and elm, with a fair amount of linn, white maple, holly, magnolia, ironwood, hornbeam, and, on some of the north Texas streams, bois d'arc (Osage orange). Black walnut, which was formerly common, has been largely cut out.

On the rich, loose bottom soil the timber grows very large. Oaks reach a diameter of from 3 to 6 feet, ashes of 2 to 4 feet, and hickories of 2 to 3 feet. The undergrowth is generally very dense, so that the forest covering is close and heavy. The intermixture of species is ordinarily very complete, though of course unequal; but not infrequently some one species has become predominant. An example of this is bur oak on certain tracts in the Red River Valley, near Texarkana, which on one tract pointed out to the writer stands so thick as to resemble in exclusiveness a pure pine forest. On the lower Trinity, the San Jacinto, and elsewhere, two of the white oaks are especially abundant. On the Red River cottonwood is very heavy; the largest of this, however, occurs more sparingly mixed with other heavy timber. On the Sulphur Fork black gum in places forms almost pure forest; in other places ash and hickory do the same. Thus particular localities become known as the sources of supply in quantity of particular trees. Other examples are the occasional areas of red cedar in the forests of this type, and the bois d'arc bottoms of a few counties along the Red River.

PRESENT CONDITION OF THE FOREST.

Much of this hardwood forest has already been cut. Along the older lines of railway it has generally been culled for 6 or 8 miles back, especially of the best oak and ash. Much of the ash along the Trinity has been rafted out, and the same thing is now taking place with the cottonwood of the Red River, at present much in demand for certain lines of finishing. The ordinary grades of oak have gone for ties, the better for staves, of which great quantities have been produced in recent years. Other hardwoods have until lately either been used for ties and other purposes of railway construction, or have been shipped out of the forest as logs. Now several mills are filling orders



APPROXIMATE AREA AND DISTRIBUTION OF THE
ALLUVIAL BOTTOM HARDWOODS.

for various grades of hardwood saw products, and furniture factories are working up some lumber into the more common articles of furniture.

In spite of these heavy drafts upon it, the great body of hardwood timber in east Texas remains to be harvested. What a resource is furnished by these noble forests of high-grade woods, suitable for manufacturing into the more valuable products of the mill, the single example already mentioned of 500 square miles along the Trinity above Liberty may illustrate. But its day is at hand. Not only are local factories being erected to work up the native hardwoods, but Northern concerns also, having consumed the timber in their territory, are eagerly reaching out for new sources of supply. Hitherto Arkansas has been the field of their southern operations; now they are beginning to turn to the better Texas areas. Here is at hand sufficient raw material to support for many years establishments for working up the forests into furniture, wagon timbers, implement handles, and all manner of things now shipped into the State from great distances.

Yet the manufacturer can come none too soon for the utilization of this great timber resource. So rich is the soil that clearing for settlement is outstripping the lumberman. Field after field of unsurpassed forest is being deadened and destroyed merely to get rid of the trees. The best thing that can happen in the interest alike of the private owner and the State is the rapid development of a market for this timber, which otherwise is likely to be largely wasted, although certain to be salable at a large profit within a few years, if the impatience of the owners to realize an immediate value could be restrained.

Along the streams the alluvial bottom timber extends into the inland prairie region to a noteworthy degree, but with so marked modifications that its discussion falls more appropriately under that of the prairie region itself.

LOBLOLLY PINE AND HARDWOOD FOREST OF THE INTERIOR OF THE COAST PLAIN.

At the Gulf the Coast Plain is a treeless, grass-covered prairie. Twenty miles inland tongues of forest are found, projecting down toward the Gulf. All the way from the Sabine to the Brazos, in passing through the middle of the Coast Plain—which extends from 50 to 100 miles into the interior—one traverses alternately belts of open prairie and tongues of heavy timber. These latter follow either the streamways or the elevated ridges of porous, sandy soil which from time to time break the continuity of the heavy prairie clays. Farther inland the forest becomes almost continuous and very dense, extending in this form over practically the interior half of the Coast Plain.

The tongues of forests along the streams belong partly to the swamp

and bayou type and partly to the alluvial bottom type. East of the Trinity they form the chief areas of swamp forest. Along the ridges, however, these tongues are the seaward extension of the mixed loblolly pine and hardwoods forest of the interior of the Coast Plain. In the stream basins the characteristic forests of the alluvial bottoms tend to run back into the loblolly and hardwoods forest, just as the latter follows the sandy ridges out into the prairie; but even in these streamways the loblolly gradually enters into the mixture.

EXTENT AND CHARACTER OF THE FOREST.

The loblolly pine and hardwoods forest was estimated by Doctor Mohr to cover an area of about 7,000 square miles "lying to the south and west of the longleaf region." The transition to longleaf pine land takes place where the Coast Plain passes into the Lignitic Belt—an example of a change in forest type corresponding, not with zones of rainfall, but with a change of geological formations, as the coast Neocene formation meets the Eocene sands of the Lignitic area. This inland half of the Coast Plain, the home of the loblolly, is characterized by a higher level and a more undulating surface than the seaward half. Its altitude is from 50 to 150 feet. Low ridges of sandy, loamy, open-textured soil interrupt the compact clays and silts, with intervening depressions which are more or less swampy in wet times, and broad, shallow streamways, presenting a large area of rich alluvial land.

Each of these conditions harbors its own peculiar association of species. The sandy ridges are covered normally with pure loblolly. The half-swampy flats grow a jungle of hardwood, with some loblolly, undergrowth, climbing vines, and often palmetto thickets, in which this species attains the unusual height of 10 or 12 feet, with a trunk rising 3 feet above the ground. In the alluvial valleys the characteristic hardwoods bottom forest is found, with a sprinkling of loblolly added. Oaks are especially abundant and of excellent growth throughout the area, except upon sandy knolls and ridges, where loblolly makes a pure stand. The forests of the loblolly belt are the densest in Texas, with a very thick undergrowth of shrubs and small shade-loving trees. The "Big Thicket" of Hardin County, famous as an almost impenetrable forest, is of this type.

The abundant loblolly pine is of greatest commercial value. In the tracts of pure forest a cut of 12,000 or 15,000 feet to the acre is not rare. On the alluvial soils it is of course of much less importance.

The heavy loblolly timber is being very rapidly marketed, mostly as yellow pine lumber. It is generally called shortleaf; the term loblolly, so far as the writer knows, is used only to indicate specimens with a large percentage of sapwood, such as occur in the swampy flats or draws in the longleaf belt. These are apparently supposed to be

simply a swamp growth of longleaf pine. In heavy mixed forest, loblolly is also culled for ties, along with much white and overcup oak.

The Galveston storm of September 9, 1900, destroyed a great amount of valuable loblolly. On many thousands of acres the forest was uprooted almost to the last tree. The whole forest area west of the Trinity was more or less damaged, and was left with so much *débris* as to render damage by fire a serious menace, besides making lumbering much more difficult.

FUTURE OF THE FOREST.

While reproduction after lumbering is good in this region as a whole, under the present methods logging in pure pine forest leaves very little prospect of renewal with the same growth. A succession of inferior forest, beginning with scrub oak, is the natural sequence. Into this the loblolly appears gradually to find its way back; probably in the course of time, if sufficient seed-bearing trees were left for it to start from, it would again gain the upper hand. Some of this forest has already been cleared to make way for sugar-cane fields, and it will doubtless be further curtailed for cane, rice, and other crops, and notably for fruit raising.

THE LONGLEAF FORESTS OF THE FAYETTE PRAIRIE.

AREA.

The longleaf pine area in Texas includes about 5,000 square miles of that fine body of Texas-Louisiana timber which is unique in its isolation far to the southwest of the main longleaf belt, east of the Mississippi. The Texas portion is shaped like a broad wedge thrust in between the loblolly at the south and the shortleaf at the north, and extends southwestward to the Trinity River, where the overlapping areas of loblolly and shortleaf form its western boundary. The longleaf forest nearly coincides with the Fayette Prairie formation east of the Trinity. The altitude here is greater than that of the loblolly belt, ranging from 100 to 300 feet, and the country is rougher and better drained, although the southern margin of the longleaf belt in Orange and Hardin counties, where it really overlaps the Coast Plain, is low and poorly drained. The typical longleaf country is one of sand ridges, offering an open soil texture to a relatively great depth, into which the long taproot of the pine thrusts itself so far as to be in great measure independent of surface conditions of soil and moisture. Such open, sandy soil dries rapidly near the surface—a fact to which the drought-enduring nature of those annual plants which have access only to surface moisture bears testimony.

The depressions between sand ridges are either poorly drained flats

or well-established drainage basins. In either case they offer soil conditions which permit hardwoods to penetrate into the longleaf forest.

CHARACTER OF THE FOREST.

Longleaf pine is characteristically found in heavy forest over large tracts with a practically pure stand. Especially is this true on sandy uplands, or the true pine barrens. This purity of stand, combined with the good quality of the timber, makes the longleaf forest both the most valuable and the most easily marketed timber resource of the State. The trees make a large and perfect growth, yielding logs of a maximum diameter of from 36 to 40 inches, with a clear length of 60 feet. From the high percentage of merchantable trees, lumbering, if conducted without restriction to secure a future supply, is likely to leave standing what would form, even if uninjured at the time of operations and properly protected subsequently, but a scanty basis for a perpetuation of the forest. In point of fact, along neither of these lines has it ordinarily received any care at all.

That longleaf tends to grow by itself is due, primarily, to the fact that it can flourish where most species can not live. On the dry sands it finds a refuge from the competition which is generally too much for it on moister and better soils. In spite of its adaptation for seeking water far below the surface, it is a reasonably safe conclusion, in view of all the facts, that it grows where it does rather from necessity than preference. It is probable that if it were free to occupy better ground without having to fight for it the result would be either finer or faster grown timber, or both, than that which the tree now makes. But the first demand of the longleaf is for sunlight. With its long, clear stems, thin tops, and scanty undergrowth, its typical form is an open forest, and it can reproduce in no other. Such a tree has no choice but to withdraw to situations which other-species do not care for. The result is that, after lumbering, the thickets of hardwoods (except for scrub oaks) which are so aggressive on cleared loblolly and shortleaf lands, are conspicuously absent. It is true that hardwood species do ultimately encroach on cleared longleaf lands, but the encroachment is very slow; for, as a rule, the new growth has to bring its own soil with it, by developing a humus to grow in.

Under present conditions the longleaf does absolutely nothing toward building up a humus soil, because of the recurrent fires which prevent any accumulation of leaf litter. Naturally a longleaf forest creates an excellent humus; but, growing as it does on sandy, well-drained soil, when the fires which always become frequent with the appearance of man begin, the organic material in the forest floor is soon lost. The result is to accentuate the condition which originally

determined the natural selection of forest growth on these areas, as the dry, poor soil, by the destruction of the moisture-holding and enriching humus, becomes still dryer and poorer. There is then still less to invite the encroachment of other species than there was before.

Frequent fires, however, though without marked effect on old longleaf trees, are fatal to the growth of seedlings. In consequence a condition is developed very like that which existed on the Texas prairies when the fires were free to sweep over them annually. These prairies were kept pure grass lands; there was no evidence of the thickets of chaparral which now cover them. The longleaf lands, instead of an under forest, have a pure prairie beneath the mature forest canopy, and this prairie becomes, after logging, a savanna of tall broom-sedge grasses. That fire is the chief cause of the absence of young growth to take the place of mature pine is shown by the circumstance that where for a series of years the fires fail to sweep, a thicket of young pine appears. These patches of "orchard pine" saplings or poles are frequently met with in the longleaf belt.

RATE OF LUMBERING AND FUTURE PROSPECTS.

The longleaf pine in Texas is being cut out at the rate of some three-quarters of a billion feet of lumber each year, with a rapidly growing market and output. The ease and cheapness with which longleaf is got to the sawmill, combined with a climate which permits heavy logging throughout the year, makes possible a very rapid handling of the crop. At the present rate of lumbering it would appear a reasonable estimate that the virgin pine might hold out twenty years longer.

With the present market demands and the prevailing methods of logging, the forest is so depleted and left in such a weakened and exposed condition that no future stand can be counted upon. But there is a good deal of longleaf land on which logging fifteen or twenty years ago, when the market demanded culled stock, left a very considerable amount of young timber and imperfect or inferior old trees. Such areas, however, are being lumbered again for ties, and thus their gain in wood is continually offset.

Longleaf seeds abundantly enough, yet there is very little seedling growth. This is entirely due to the regular and frequent fires. Neither young longleaf nor any other trees are able to start in the face of these. But wherever the fire has failed to sweep for a number of years, and the forest is sufficiently open, one finds thickets of young longleaf, the borders of which dwindle away in scattering, fire-stunted saplings, and a final border of young seedlings half hidden in grass which has escaped fire for a year or two.

HARDWOOD AND SHORTLEAF FORESTS OF THE LIGNITIC BELT.

EXTENT.

These are by far the most extensive of the east Texas forests. Of the pine timber there are some 30,000 square miles, but the forest type, with oaks forming the chief part of the mixture, covers a much larger territory, spreading over the whole of the Lignitic Belt to its western margin at the Black Prairie, and far southwestward into the Rio Grande Plain. The pine area lies between the longleaf and loblolly belts and the Red River, reaching westward to Hopkins and Anderson counties. Beyond this the pine drops out, perhaps because of the lessened rainfall, and the post oak region is entered. It is the writer's belief, however, that shortleaf pine can be made to flourish on most of the Lignitic formation westward to the Black Prairie, and that it has economic possibilities in connection with forest management for the entire region.

The shortleaf and post oak forests are found on the highest and roughest parts of the Tertiary plain which covers east Texas down to the Coast Plain. The shortleaf area begins in Houston and Angelina counties, at an altitude of over 300 feet. Its appearance is rather closely associated with that of the characteristic red clays found thence northward to Texarkana. This whole Tertiary plain, which includes the longleaf area, is a region of sand beds and underlying clays, an unconsolidated mass favorable to tree growth. It will be recalled that the region has already been described as the remnant of an ancient plain worn away by erosion, in which the streams have established wide drainage bottoms, with second bottoms or benches rising to the divides from 100 to 200 feet above the present stream level. It is on these uplands that the shortleaf and oak prevail. The alluvial bottom is covered by mixed hardwood forest.

COMPOSITION OF THE FOREST.

Aside from the shortleaf the upland oaks hold the lead. Of these the post oak is the most abundant and universal; after this, black jack and blue jack—the latter especially to the east. Besides these there are two upland hickories—the nutmeg hickory and the pignut. Many of the alluvial bottom species also, pushing up the slopes and following the innumerable small ravines and draws, penetrate into the upland forest at every point. Elm, white oak, red oak, and sweet gum are to be found well out upon the upland.

THE SHORTLEAF PINE.

The only important timber tree is the shortleaf. Of its total 30,000 square miles of area, however, only a small part is in the region of its



FIG. 1.—OPEN SHORTLEAF PINE FOREST; HEAVY UNDERGROWTH OF YOUNG PINE, SCRUB OAK, ETC , ON UPLAND SANDY SOIL NEAR GARRISON.



FIG. 2.—SHORTLEAF PINE DEADENING NEAR GARRISON; A GOOD STAND OF LARGE POLES WITH MANY GOOD TREES DESTROYED TO MAKE A COTTON PATCH.

best development, which takes in, with northwestern Louisiana and southern Arkansas, the northeastern counties of Texas. In these counties a shortleaf forest of considerable extent originally stood. Of it Doctor Mohr wrote: "North of the Sabine River, from Longview through Cass and Bowie counties, the shortleaf pine forms compact forests over many hundreds of square miles."^a Most of this pine has been cut out.

On the vastly greater area where the pine is more or less diluted by hardwoods more remains standing. Much of it is too scattering to support an active lumber business, but patches of almost pure pine bring up the average. But despite the fact that most of the territory is on the border of the shortleaf pine belt, the noteworthy size of the individuals shows that the conditions are favorable for the growth of the tree. Veterans over 3 feet in diameter are frequent, and apparently reliable reports speak of trees with a diameter of 6 feet and more.

Shortleaf lumbering began earlier than that of longleaf and loblolly, because the first railroads cut through its territory. In 1880 the output of shortleaf was 146,420,000 feet, against 61,570,000 of longleaf. To-day it can hardly amount to one-tenth that of the longleaf. The very large mills, like those at Texarkana, do not depend to any great extent on the Texan supply. Smaller mills, with a daily capacity of 20,000 feet, more or less, are clearing up the lesser patches and the large trees scattered through the mixed forest along the lines of the railroad; but all the better bodies of pine have been logged.

In the pure pine forests very little promising timber was left standing, and the land was usually overrun by oak thicket. In the vicinity of Texarkana, however, a good cut of pine has recently been made on land logged over thirty-five or forty years ago, and in the northeastern counties there are rather frequent thickets of second growth, and a good deal of scattering pine saplings. Still the prevalence of scrubby oak forest everywhere gives the whole an unpromising look. In the mixed forest a heavy oak timber is already on hand to take the place of the pine. In every case, after the removal of the pine the forest is of small commercial value, capable of furnishing little but fuel and coarse construction material.

Left to itself, the forest reconquers its territory aggressively. Even the pine is a good ground-gainer here, and with a reasonable amount of assistance could be made a valuable resource on many an unpromising acre. But wherever there is a loamy soil, undoubtedly it is better cleared and put under cultivation. This is taking place even to the length of sacrificing some excellent patches of almost pure shortleaf (see Pl. II, fig. 2). Much of the inferior forest may very properly be

^a Timber Pines of the Southern United States. Bul. 13, Bureau of Forestry.

converted into fruit farms, a form of enterprise which is making substantial progress and seems to have a promising future. Nevertheless, even under agriculture the region will need a great deal of forest, though of this inferior quality, for protective purposes, both to conserve moisture and to prevent erosion, to which the soils are particularly susceptible.

THE POST OAK FOREST.

In the Lignitic Belt, as we have just seen, the upland timber from Hopkins County on the north and Anderson on the south (the western limit of the shortleaf) to the Black Prairie is mainly oak. This oak timber follows the southwesterly extension of the sands and gravels and clays of the Lignitic Belt far into the Rio Grande Plain—to the sand ridges about Carrizo Springs, for example. But isolated from the main belt are other extensive areas of this type of forest, which in general occurs westward to the one hundredth meridian wherever the geologic formation offers conditions similar to those in the Lignitic Belt—namely, pervious sand and gravel beds and sandy red clay hills. Thus the two areas of special note, the Upper and Lower Cross Timbers (see Map I), are of this type, as are also the open forests of the granite region, of the Carboniferous area, and of the isolated gravel terraces such as those above the Colorado River at Austin. In the Rio Grande Plain, however, although the favorable soil conditions continue, the post oak dwindles out a little beyond the Nueces, after having followed the Fayette Prairie formation from east Texas to this point.

The area of granite exposure, with the carboniferous limestone bordering it, and the main carboniferous area north of the granite, with the Upper Cross Timbers, give an almost continuous belt of post oak timber from Gillespie County to the Red River. The Lower Cross Timbers, running from the Red River to the Brazos, along the ninety-seventh meridian, together with numerous smaller tracts of scattered shore-line gravel beds, increase the area of post oak timber west of the ninety-seventh meridian to considerable proportions, and provide a vast quantity of useful, if inferior, construction material over an area in which it is most needed.

There is more to notice in this type than the mere absence of pine timber. Unlike the types previously described, it is a forest adjusted to arid conditions. It is, in fact, the type which the Atlantic forest assumes when it passes into the arid southwest. Naturally those areas of it which lie so far west as Llano, in central Texas, or Carrizo Springs, in the Rio Grande Plain, mark the extreme degree of change brought about by drought. It will be recalled that in the Lignitic Belt there were species of hickory, Spanish oak, and some of the alluvial bottom timber, besides much woody undergrowth, in addition to the pre-

dominant post oak. Westward not only the pine but most of these as well disappear, except on areas where the soil water is held available, as in the Cross Timbers and along the Pedernales at Fredericksburg. In general, in going westward not only is there a sifting of the moisture-requiring species until there remains only the one or two species of barren oak, but also these oaks themselves change their appearance. Instead of standing with their crowns in contact, they become isolated, with very short trunks and rounded crowns, so that the forest presents an open, park-like appearance, with a prairie-grass floor.

The post oak is not a timber of much commercial value—even less so the black jack. But since the former attains a rather large growth, there being quantities of it 15 to 24 inches in diameter, with a clear cut of 10 to 15 feet, it is available for certain large construction timber, and has especially been extensively used for ties. This, however, has been chiefly on new lines through post oak timber. As a fuel the post oak is a great source of supply, and lying, as it does, beyond the region of pine and other hardwoods, and in a region where fuel is extremely expensive, it is marketed in enormous quantities. The supply would seem to be inexhaustible. The post oak belt, where it is crossed by the Houston and Texas Central Railroad, reaches from Elgin almost to Brenham, a distance of 60 miles. On the International and Great Northern it begins at Rockland and extends to Neches, 230 miles, before the shortleaf pine begins noticeably.

In the writer's observation the post oak makes habitually an irregular, imperfect growth, and is very much affected by disease, especially by the infection of certain fungi which cause dry rot. To such an extent is this true that its value for fuel is very seriously impaired because of the doty wood.

Agriculture in the post oak country.

The part of the Lignitic Belt on which grows the post oak forest lying to the east and southeast of the Black Prairie—that is, the western part—has been brought more extensively into cultivation than the eastern, which has the shortleaf timber. This means, of course, that the oak timber has been or will be cleared from such tracts as have loamy soil, or any soil upon which cotton can be raised. The timber will very properly be restricted more and more to the poor soils; but its economic value ought to be improved in proportion to its restriction. Of course it performs the functions of soil protection and moisture conservation to a considerable degree, but this could be accomplished equally well by timber of better quality. It must be possible for shortleaf and loblolly pine to flourish over much of this region—certainly as far west as the tract of loblolly pine on the Colorado at Bastrop. With the increase in agricultural and related

activities, this will become a region in which timbered tracts will be maintained as adjuncts to farms, furnishing local fuel and construction supplies and at the same time protecting against soil erosion and deterioration. It will then be well worth while to try what the pine will do.

TIMBERED AREA OF THE EDWARDS PLATEAU AND OF HILLS AND
BLUFFS NORTHWARD FROM IT.

Next to the forest area of east Texas, this is the most important timbered region of the State. The Edwards Plateau is the rough, deeply eroded southern margin of the Great Plains, which end abruptly in this part of Texas at the vast fault line, or downthrow, known geologically as the Balcones Escarpment. This escarpment is very prominent along the southeast and south from Austin to San Antonio, and westward to the mouth of Devils River. The body of the plains in this region has been so deeply eroded as to present a picturesque mountainous country, with all the diversities arising from erosion and weathering of limestone strata of various degrees of hardness and differences of texture. Thus there are steep bluffs and deep gorges, isolated buttes, long, even slopes covered with talus débris, or flatter upland covered with coarse fragments of hard limestone boulders—the “hardscrabble” country. Again, there are small valleys and lower flats upon which a fair amount of rich soil has accumulated, thus offering limited agricultural opportunities. The area embraces perhaps 15,000 square miles, with considerable additions in the hills and bluffs along the streamways in north middle Texas, where similar physiographic conditions occur.

The region lies mostly to the west of the ninety-eighth meridian, and consequently in a rainfall zone of under 30 inches annually. This amount of rainfall, especially with its very irregular seasonal distribution, is too low to maintain a forest cover, except under conditions where the rock strata are broken up sufficiently to retain and give up gradually the precipitated moisture. It is interesting to note this close dependence of a certain type of vegetation upon a particular phase in the history of a geological formation. Thus, climatic conditions remaining the same, if the Edwards Plateau were an uneroded highland, its vegetation would, under natural conditions, be open grass prairie. As a matter of fact it is being cut down to the coast level as fast as erosion can do it, and coincident with this it is in process of transformation from a grass prairie to timberland. This transformation is being hastened by the interference of man. Both agriculture and grazing have operated to prevent the recurrence of prairie fires, which, so long as they were periodic, kept the field swept clean of woody vegetation. The grass thrived under this burning; seedlings of trees were killed. Again, both have resulted in breaking up the heavy sod cov-



FIG. 1.—DEADENED FIELD OF RIVER BOTTOM HARDWOODS NEAR GARRISON.



FIG. 2.—LIVE OAK ENCROACHING ON THE COAST PRAIRIE BETWEEN THE BRAZOS AND SAN BERNARD RIVERS IN BRAZORIA COUNTY.

ering which of itself operated effectually to keep out tree growth; agriculture, by turning under the sod and putting crops in its stead; grazing, by killing out the grass by overpasturing. The neglected field and the overpastured and trampled prairie then became an inviting territory for the invasion of weeds and of woody growth, which quickly establishes a thicket and gradually a heavy young timber covering.

It is not to be inferred that the whole Edwards Plateau is a continuous timberland. On the contrary there is a considerable amount of open grassland. Even more of it is covered with a scattered scrub timber, but there is enough real timber to warrant the classification of it as a timbered country. The aridity of the climate is such as to exclude any such thing as a dense forest, except, as we have seen, in the deep, sheltered, and watered canyons. The timber of the Edwards Plateau is not one of deep shade, and of course is not accompanied by all those plants and animals which love the cool twilight atmosphere of dense forests. It is a dry-climate forest. The growth is stunted, the wood dense and hard, the branches rigid, the foliage somber, the leaves small and stiff; the climate is written in every feature.

GEOGRAPHIC RELATIONS OF THE SPECIES.

The Edwards Plateau is a common meeting ground for species from the Atlantic forest belt, from the southern Rocky Mountains, and from the north Mexican highlands. Yet the timber vegetation contains a very considerable amount of species either limited to Texas or occurring chiefly there. The situation comes about in this way: Numbers of Atlantic species, in pushing along the Coast Plain southwestward, have encountered the more arid climate of the Southwest. Surviving, they have become permanently changed into new species in adapting themselves, though showing close kinship with the species from their ancestral region. This circumstance was noted by Engelmann in his early articles on Texas. He says:

* * * But shrubby species peculiar to that region represent the larger trees of the same or analogous genera of the more northern parts of the country. The stately walnuts of your [northeastern] forests are reduced to the low *Juglans nana* (*J. rupestris*), a shrub that bears nuts the size of a musket ball. In place of the mulberry of your river bottoms, we find there the small *Morus parvifolia* (*M. celtidifolia*) with leaves one-fourth the size. The fine hackberry (*Celtis occidentalis*), one of the largest trees on the fertile lands of our woods, is there represented by an allied genus, *Acanthoceltis* (*Celtis pallida*).

Of course wherever these species have passed on southwestward beyond Texas, as numbers have done, they can not be said to be peculiarly Texas species. Yet it must have been in the Texas region that the change from the ancestral species occurred.

The more prominent of these species are tabulated below:

<i>Texas species.</i>	<i>Atlantic species.</i>
Mountain cedar (<i>Sabina sabinoides</i>)	Red cedar (<i>Juniperus virginiana</i>).
Mexican walnut (<i>Juglans rupestris</i>)	Black walnut (<i>J. nigra</i>).
Mountain live oak (<i>Quercus fusiformis</i>)	Live oak (<i>Q. virginiana</i>).
Mountain Spanish oak (<i>Q. schneekii</i>)	Texas oak (<i>Q. texana</i>).
Mexican mulberry (<i>Morus celtidifolia</i>)	Red mulberry (<i>M. rubra</i>).
Texas redbud (<i>Cercis reniformis</i>)	Redbud (<i>C. canadensis</i>).
Texas buckeye (<i>Ungnadia speciosa</i>)	Buckeye (<i>Aesculus</i> sp.).
Mexican persimmon (<i>Brayodendron texana</i>)	Persimmon (<i>Diospyros virginiana</i>).
Granjeno (<i>Celtis pallida</i>)	Hackberry (<i>Celtis</i> sp.).

The principal Rocky Mountain species represented in the Edwards Plateau timber are the piñon pine, probably the Rocky Mountain cedar, and four or five oaks, among which are Emory's oak, gray oak, and switch oak.

Of Mexican or southern species there are the madroña, frijolito, gum elastic, and lignum-vitæ.

THE CEDAR BRAKES.

The dense growths of cedar form the most characteristic feature of the vegetation of the Edwards Plateau, and constitute a valuable timber resource. They are found also, upon hills and bluffs offering similar conditions, northward and westward as far as the canyons and escarpment hills of the Staked Plains.^a

The data are not at hand to warrant even an approximate estimate of the area covered by cedar. The Colorado River brakes, one of the largest series, are almost continuous from Austin to the San Saba country; it is perhaps no exaggeration to estimate the area of these alone at 500 square miles.

A typical cedar brake is so dense as to be penetrable only with extreme difficulty. The trees stand thickly, and also branch profusely from near the ground. They are of stunted growth, but with wide-spreading, interlocking branches. Consequently they produce very rough, knotty sticks. In the lower brakes, on better soil, the growth is taller and clearer than where the conditions are less favorable, and yields sticks from 10 to 18 inches in diameter at the base and from 12 to 18 feet long. But the stands are so thick that they produce a great quantity of timber. Whole communities, like Austin, for example, are largely dependent upon the cedar for fuel, especially from September to March, and the consumption for this purpose far exceeds all other uses. Hundreds of thousands of sticks have also, for many years, been annually consumed for rail fences, posts,

^aThe Staked Plains cedar may be one of the western species which replace the mountain cedar west of the Pecos River.

telegraph and telephone poles, ties, house blocks, sills, and all manner of rough construction.

The cedar brakes have more than a commercial value. Cedar can grow on the most soilless limestone débris, and its wide, low branching and thick stand make it a close cover which collects soil, prevents washing, and holds back the water to a marked degree. It is also a strenuous ground holder and ground gainer. It comes up quickly after fire and cutting, and would soon renew itself everywhere were it not that steep hillsides, with loose friable limestone, wash too much to permit a new growth to start well. In Bell County a characteristic cedar brake has succeeded a stand of Texas mountain oak, having occupied the ground exclusively after the removal of the latter. Near Austin cedar brakes that were cut close twenty-five years ago are now being cleared a second time and are yielding a vast amount of fuel, although too young to furnish much split wood. (Pl. IV, fig. 1.) On the other hand, a very competent observer testifies that toward the southwest, in the more arid part of its range, the cedar recovers very slowly after clearing, and almost not at all after fire. Here it is succeeded by oaks.

A deplorable loss of cedar has taken place from brake fires. For half a century these have periodically occurred; areas which have not been burned over are the exception. Every old settler can tell of big fires which burned for days. In July, 1901, a very disastrous fire occurred near Marble Falls, in which about 600 acres of valuable cedar were destroyed.

OTHER HILL TIMBER.

In addition to the cedar, other species of the hill timber are constantly being drawn upon for fuel and the rough construction material in demand on ranches and farms. While this demand results in the denudation of many arid hills upon which timber growth will be reestablished only with great difficulty, on the whole the consumption is not keeping pace with the spread of the timber area. An interesting case in point is furnished by conditions along the line of the Austin and Northwestern Railway, between McNeil and Burnet. In the vicinity of the former town the country is being rapidly denuded of timber to furnish fuel for the limekilns. But immediately beyond this, large tracts of dense thicket exist where formerly were fields or pastures, and so on up the line it is manifest that the hill timber is encroaching rapidly upon the prairie. On the other hand, the areas being denuded are left in an exposed condition where erosion is imminent, and the soil accumulation of years may thus be suddenly lost.

To sum up, then, the timber of the Edwards Plateau is gaining ground, but is also losing possession of some of the steeper hillsides. Its immediate value consists in the amount of fuel and rough con-

struction stuff furnished, in which the cedar excels. Its greater and permanent value lies in its capacity to furnish protection, whereby soil can be collected in difficult situations; to prevent erosion from sudden bursts of rainfall; and to retain a large percentage of the rainfall instead of permitting it to run off in destructive floods.

THE LIVE OAK TIMBER BELT.

In Texas, as in the South Atlantic States, the live oak occurs on the Coast Plain. The live oak belt is particularly noticeably between the Brazos and the Nueces rivers. But there is also a north and south belt lying chiefly between the ninety-sixth and ninety-ninth meridians, where the occurrence of live oak is more or less constant. This belt includes a portion of the Edwards Plateau, in which the mountain form of the live oak occurs often in patches of pure forest. But in the agricultural areas of the Black and Grand prairies and in the lower *débris* soils of the granite country—e. g., southward from Llano—the live oak grows to its characteristic proportions, and while in no sense a considerable factor commercially, it is a most valuable tree for ornament, shade, and the production of woodlot material, in a region where without it farms and ranches are apt to appear desolate. In the coast country, however, the live oak is at its best. In Fort Bend, Brazoria, Wharton, and Matagorda counties it reaches splendid proportions. In the neighborhood of the immediate valley of the San Bernard this large growth formerly stood so close as to be literally live oak forest. The heaviest of this—at least so far as observed by the writer—has been deadened in breaking out cotton fields. The soil here is a very deep, black, waxy alluvial sediment. Along the Brazos, where the trees, though fewer, are even larger, the soil is a more porous, sandy alluvium. This large timber suffered irreparably from the Galveston hurricane of September 9, 1900. The veteran trees, 3 to 5 feet in diameter, were especially singled out for the fury of the storm.

The live oak of the Coast Plain westward, toward the Nueces—in Live Oak County, for instance—yields noticeably to the increasing aridity of the climate, becoming a more stunted open growth, although staunchly holding its own as to numbers. Throughout this belt the live oak is gaining ground. Formerly it was limited to strips along the rivers and “islands” in the prairie—that is, to minor drainage branches. At the present time it is rapidly spreading over the grass prairie. The conditions between the Brazos and San Bernard west of Columbia afford an excellent illustration of this. The low divide between these streams was, a generation ago, open prairie. Now, except for cotton fields, it is mostly woodland. A plantation home from which the town of Columbia could once be seen is now shut off from a view of more than a few hundred yards in any direction.



FIG. 1.—CEDAR BRAKE NEAR AUSTIN, WHICH HAS GROWN UP AFTER A CLEARING TWENTY-FIVE YEARS AGO.



FIG. 2.—THICK GROWTH OF SMALL MOUNTAIN OAK ON THE SIDE OF A DEEP GORGE IN THE EDWARDS PLATEAU COUNTRY NEAR AUSTIN.

This encroachment of live oak shows how inadequate is the cultivation of that part of the coast country, and reflects the unfortunate industrial conditions which allow lands unsurpassed for depth and richness of soil to become relatively unproductive.

THE RIO GRANDE PLAIN CHAPARRAL.

To one who had known the Rio Grande country forty years ago it would never have occurred that this arid region could ever lay claim to being in any sense a wooded country. Yet at the present time the wooded area is vastly more extensive than the open prairie. The Rio Grande Plain is now as truly a forested belt as are the more easterly portions of the Atlantic Coast Plain, but its aridity has so stunted the growth of the species as to make shrubs of them. The result is the peculiar and characteristic chaparral, or pygmy forest.

The associated species are of totally different stock from those hitherto considered. In geographic affinity they are mostly Sonoran—warm-temperate or semitropical desert species. A few of them are really tropical. Of those which grow to valuable size, there are Texas ebony, huisache, Texas catsclaw, mesquite, retama, and green-bark acacia. These, it will be noted, are all members of the bean family. Four of these, and double that number of shrub species, are of the mimosa kinship, a noteworthy fact, inasmuch as species of this kinship form a conspicuous part of the vegetation in nearly all the large arid regions of the earth—Argentina and Chile, Central South Africa, Australia, the Mediterranean countries, Persia, and Arabia. This fact helps to give a comparative estimate of the cultural possibilities of the Rio Grande country. In the selection of species for planting one could cover a range of trees far wider than would be possible on the dry plains northward, including even hardy tropical or semitropical species.

Besides the chaparral—which for the most part consists of shrubby species, often not exceeding 4 or 5 feet in height—the streams of the Rio Grande plain have a considerable amount of timber characteristic of the prairie streams, already discussed as river-bottom timber of the prairie region, which, with the westward extension of the post oak and the live oak types, furnishes a very considerable amount of usable construction material and fuel. On the whole, the chaparral is a very serious evil from its tendency to lessen the capacity of the country as a cattle range.

The geographic relation of the Texas region to the Atlantic Coast Plain, to the northern prairies, the Great Plains, the Rocky Mountains, the Mexican plateau, and the Gulf tropical zone is such that its vegetation as a whole shows affinities with all these regions. One may not inaptly speak of Texas as the battle ground for supremacy of plant races. In considering the timber vegetation we have continually noted the

strenuous efforts of Atlantic species to push southwestward, even in the face of an arid climate. The spectacle of a counter invasion is presented in the case of the chaparral, which is a horde of Sonoran shrubby species pushing their vanguard even into the agricultural areas of the State.

THE MESQUITE.

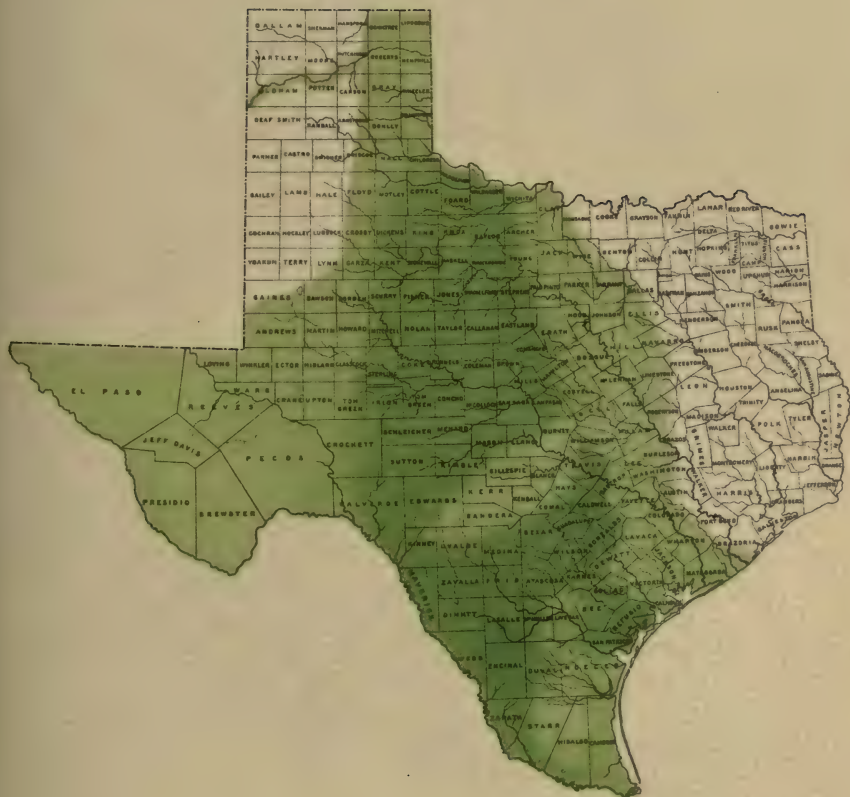
Among these the mesquite is the dominant and strenuous species. Its spread northward and eastward from the Rio Grande country during the past fifty years has been a marked phenomenon. By its invasion mile after mile of treeless plain and prairie have been won and reduced to the characteristic orchard-like landscape. In the coast country, and likewise in the Black Prairie region, it has passed the Brazos. It has pushed northward over the Staked Plains, covering half their area. Along their eastern front it has passed over Oklahoma and into southwest Kansas. Miles of the level prairie in the Abilene country are covered by mesquite. Large areas of the fine compact soils of the granite country harbor it. San Antonio is half surrounded by a "mesquite forest." Pastures about Austin are growing up in mesquite. The name "mesquite flats" points to the preference of this tree for low or level areas with fine compact soils, by which preference it avoids competition with native woody species, which are on rougher ground and more open, porous soils.

The coming of the mesquite has brought a vast deal of wood and much forage, but the agricultural areas do not need these at the price, and more arid areas would be better off in the long run in open grass pastures. Where mesquite is accompanied by prickly pear or other thorny species, as it is to the southeast of San Antonio, it becomes a serious menace to grazing interests and a heavy expense to farmers.

This encroachment of mesquite is partially accounted for by its weed-like capacity for occupying new ground, its preference for the flat country and compact soils characteristic of the grass prairies, the weakened condition of the grass covering due to overpasturing, which handicaps it in its efforts to maintain pure grass prairies, and by the influence of cattle in scattering the beans.

THE TIMBER OF THE CORDILLERAN REGION IN TEXAS.

This region is a part of the South Plateau of the Rocky Mountains. The more or less disconnected and isolated mountain masses which rise above it frequently exceed 6,000 or 7,000 feet, and in the Guadalupe reach 9,500 feet. The region lies in an extremely arid belt, but its altitude not only reduces the annual temperature but also notably increases the rainfall, which by virtue of the broken and tilted strata is retained to be doled out continuously, thus giving a measure of constant moisture which permits timber growth. Of this timber growth two types may be distinguished: (1) That of the foothills and slopes



DISTRIBUTION OF MESQUITE (*PROSOPIS GLANDULOSA*) IN TEXAS

below 5,000 or 6,000 feet, which is a desert type; and (2) the timber of the high summits and the upper watered canyons, which belongs to the Rocky Mountain type.

THE TIMBER OF THE FOOTHILLS AND SLOPES.

This type is analogous to that of the Edwards Plateau, and includes some of its species. The chief species are different, however, and belong to higher altitudes. The piñon pine is the most generally distributed, occurring upon the slopes of the Guadalupe, Davis, Chisos, and Organ mountains, and also on the higher ridges and bluffs of the Great Bend country, from the Southern Pacific Railroad to the Rio Grande. "In the Chisos Mountains, which it occupies exclusively, it becomes a straight tree with a trunk a foot in diameter, and could be sawn into useful lumber of fair quality. * * * It reaches about the same proportions in the Davis and Organ mountains."^a With the piñon pine occur western cedar, thickbark cedar, Emory oak, and one or two other oaks, besides shrubby and otherwise insignificant species.

THE TIMBER OF THE SUMMITS AND HIGH CANYONS.

This type consists of isolated islands of Rocky Mountain forest, whose principal species are yellow or bull pine, red fir, and limber pine, with Emory oak and gray oak of the previous type but making larger growth. This timber is limited to the Guadalupe, Davis, and Chisos mountains. The yellow pine and the red fir attain, for them, relatively small dimensions. The yellow pine grows to be from 1 to 2 feet in diameter and from 30 to 50 feet tall, "yielding [in the Davis Mountains] clear lumber 18 inches wide" (Havard). Second to it in size and quantity is the red fir. Of the oaks, the Emory oak becomes the largest tree. To quote from Havard: "On the El Paso road, where it skirts the southern base of the [Davis] mountains, this stately oak becomes the main feature of the sylva; its straight trunk is from 2 to 4 feet in diameter, while its mass of shining foliage reaches the height of 60 feet."

This timber of the foothills and mountains constitutes something of a resource for mining operations, if it should prove to be available for them. In the development of the cinnabar mines in Brewster County the greatest lack is fuel, of which the only considerable supply is in the Chisos Mountains.

About Fort Davis most of the available pine was sawed while that was still a military post. The timber in the Guadalupe is said to be practically inaccessible and only usable upon the ground. In their capacity of protection these timbered slopes and canyons assist in maintaining several streams of good flow, whose waters are invaluable for irrigation and for watering range cattle.

^a Havard, Report on the Botany of Southern and Western Texas, 1885.

FOREST MANAGEMENT.

The State of Texas, with a merchantable forest that covers only 10 per cent of its entire area, cuts nearly a billion board feet of lumber a year. The lumber industry is exceeded only by the cotton and cattle industries. But of its comparatively small area of timberland 125,000 acres are cut annually, and cut in such a way that the land will not grow valuable forests again. Other timberlands, valueless for lumber, but of the first importance as a protection for agriculture and as a source of water supply, are burned and destroyed without regard for their great usefulness. Under present methods the exhaustion of a great economic resource is taking place, and conditions affecting the prosperity of wide areas are rapidly changing for the worse, while the public interest in the most effective utilization of the potential wealth of the State as a whole remains unprotected.

The alternative is forest management. The State needs extensive forests which shall be both permanent and productive. It can not afford to follow the method of prohibiting all cutting on reserved forest areas, as the State of New York has done. The products of the forest are at least as important to the State as the forests themselves. Not that all areas now under forest ought to remain woodland; clearing for agriculture is to be welcomed wherever agriculture will pay, and farms will ultimately occupy much of the country now under timber. On the other hand, forest extension may be expected to add other areas, now valueless for any purpose, to the list of woodlands. But whatever changes may take place in the extent and the location of its forests, it devolves upon the State of Texas to see to it that the forests which it needs are preserved. The means to this is forest management, or the practice of forestry, either by private owners or the State, or both.

Forestry in Texas should aim at the following ends:

- (1) To discover and introduce lumbering methods which will provide for a future crop at a reasonable cost.
- (2) To devise economical fire protection for cut-over lands.
- (3) To prevent the destruction of forest growth which is needed to protect streams.
- (4) To promote the maintenance of woodlots in connection with farms by spreading information concerning their care and usefulness.
- (5) To plant trees in regions where there is now no forest growth, but where it can be usefully introduced.

Toward the first and second of these ends notable progress has lately been made as a result of the action of private owners, under the advice of the Bureau of Forestry of the U. S. Department of Agriculture.

It is a matter of congratulation that by far the largest owner of



FIG. 1.—CHARACTERISTIC VIEW OF THE TIMBER, MOSTLY MOUNTAIN CEDAR, ON THE EDWARDS PLATEAU, 20 MILES NORTHWEST OF AUSTIN.



FIG. 2.—TYPICAL POST OAK FOREST OF THE GRANITE COUNTRY IN LLANO COUNTY, LOOKING ACROSS FAIRLANDS VALLEY FROM GRANITE MOUNTAIN.

timber lands in the State, controlling perhaps 80 per cent of the virgin longleaf pine forest, besides much cut-over land, is preparing to introduce conservative forest management. The success of this plan will be nothing short of revolutionary in its effect upon the Texas lumber industry. When it can be shown to the private owner that it pays better to utilize the forest as a permanent source of supply than to destroy it, the public and the private interest in the forest become identical, and the future of the lumber industry is assured.

THE PROSPECTS OF PRIVATE MANAGEMENT IN TEXAS.

Two facts stand out in a consideration of the forest resources of Texas and the forces now in operation which affect them: (1) That at present the forests are being rapidly and dangerously diminished; and (2) that there is a good opening to check their exhaustion, if the proper steps are taken to that end.

The main hope of forest preservation lies in private management. Ninety-five per cent of the timberland of the State is already private property. The possibilities of private management are along the lines (1) of commercial forests to supply the market, and (2) of woodlots on farms to supply local needs and (to some extent) protection.

CONSERVATIVE LUMBERING ON VIRGIN TRACTS OF VALUABLE COMMERCIAL TIMBER.

The forests which supply commercially valuable timber are the longleaf, shortleaf, and loblolly pine forests, and the mixed hardwood forests of alluvial bottoms, embracing the best of the east Texas timber region.

CONSERVATIVE LUMBERING IN THE LONGLEAF PINE FOREST.

The longleaf pine forests now furnish four-fifths of all the pine which reaches the Texas market. Yet the longleaf pine area is relatively very small, and is rapidly diminishing. It was estimated by Doctor Mohr^a to have been originally 5,000 square miles—approximately 3,000,000 acres—with a stand of presumably some 30 billion board feet of lumber. But lumbering has been going on for twenty-five years, and on a large scale for fifteen years. The yearly cut has exceeded half a billion board feet since 1895; in 1900 it was at least three-quarters of a billion feet. Probably half the area has been cut over; fifteen years more of virgin timber cutting at a rate of a billion feet a year would complete the harvest. There would then be left only what has matured since cutting began. As a matter of fact some tracts are already being cut a second time. This is possible because in

^aTimber Pines of the Southern United States.

the earliest cutting only the finest trees were culled; enough was left to furnish, after a growth of from twelve to twenty years, a forest which now invites the lumberman's return. But there is at present a market for anything that will square 4 or 5 inches. The result is so close a cutting that nothing is left which can mature another crop inside of fifty or seventy-five years; indeed, in very many instances, the forest is practically destroyed. (Pl. VI.)

The renewal of the forest is made impossible by the agencies which prevent the growth of seedlings. The worst of these is fire. Fires are invited, and their destructiveness is very greatly increased, by the great quantities of waste left after logging. Often they are regularly set by cattle owners to improve the range. But for them, in the wake of lumbering, great quantities of seedlings would quickly spring up. Seed is produced in great abundance every three or four years. The seeds are widely distributed, and germinate prolifically. Wherever fire has been kept away, thickets of seedlings, saplings, and poles show what would be the general condition if the forests were protected against its great enemy.

Permanent management of Texas longleaf pine forests is impossible without both a reform in lumbering methods and effective fire prevention. The harm done by forest fires is so little appreciated, and methods of preventing them are so little understood, that it is doubtful whether general fire protection by private owners can be expected. It is for the State to consider whether some form of fire protection at public expense is not called for by the interest of the community at large, in forests as it is in cities. Assuming, however, that fire protection is impracticable, what can be done in the way of conservative lumbering? A plan looking only to a second or third cutting might disregard the matter of seedlings; the small timber now on the ground, which would mature within from twenty to fifty years, would furnish the crops. It should be a matter of concern to every owner of longleaf pine timberland in Texas to determine whether it would not be a wise business policy for him to cut no sound pine below a certain diameter limit. Many tracts lumbered fifteen to twenty years ago, when few trees below 18 inches in diameter were taken, are now being lumbered for large cuts of pine. Judging from these, no great change in the limit to which trees are now cut would have to be made in order to leave the basis for a second crop of timber from lumbered lands within a reasonable time. The Bureau of Forestry has just completed a field study of extensive longleaf pine lands in Texas, the results of which should show the financial returns to be expected from the conservative lumbering of longleaf.

The policy indicated would require the modification of present lumbering methods, and would prevent the destruction of small trees in removing the large ones. The expense of lumbering would thereby

be slightly increased, but at an ultimate gain which would more than justify the outlay.

More serious in the eyes of owners are likely to be the objections that there is a present market for practically all of the timber, which if left will be exposed to loss by fire, wind, theft, and disease; that money would be tied up in growing timber for a long term of years; that tramways would have to be provided for each cutting at great expense; that meantime taxes would be eating up the profit.

On the other hand, it is to be said:

(1) That while small timber is salable, the profit on timber squaring over 8 or 10 inches is so much greater that to cut it earlier involves a wasteful loss.

(2) That the price of high-grade lumber will probably increase very materially during the next fifteen or twenty years. This is indicated by the rapidly decreasing supply of pine timber in eastern North America with an increasing demand; by the history of the price of white pine; by the steady upward trend of southern pine during the past decade; and by the rapid exhaustion of longleaf pine in Texas now actually in progress.

(3) That with agricultural and industrial development the land itself is rising in value.

(4) That large lumber companies, organized to do business for long periods, are in the field with complete outfits, which they are constantly transferring from one tract to another. Their trams are all the time being laid, taken up, and relaid. They are equipped with everything needful for economical lumbering on a large scale. The one formidable danger which they have to face is that they may be left without trees to cut. The strong probability is, not that the owner of a good forest will have trouble in getting his timber to market, but that invested capital will have trouble in finding forests to occupy the plants on the continuous operation of which its profits depend.

CONSERVATIVE LUMBERING IN SHORTLEAF PINE FORESTS.

Of pure shortleaf forest not enough remains uncut to make the question of conservative management important. Of mixed pine and upland oak forest there is yet a fair amount untouched, but its value is not great enough to support lumbering on the scale practiced in the longleaf forest. It is really an area of small operations, and the only opening for an application of principles of forestry is to conduct the lumbering in such a way as to permit the young pine now standing to develop, and, so far as possible, to favor pine in the reproduction. The forests of this region will find their chief usefulness as protective forests and woodlots.

CONSERVATIVE LUMBERING IN LOBLOLLY PINE FORESTS.

It will be recalled that the loblolly area is one chiefly of mixed pine and hardwoods, that it is the most densely forested area in the State, and that the coast country, which it occupies, is low and flat—a vast alluvial plain.

Although forest renewal is extremely aggressive, the value of the land for rice farms, sugar plantations, and other agricultural uses is such that, with the influx of settlers, the greater part of it will be brought under cultivation and the forests will be left to occupy only the less valuable tracts. Upon these, valuable commercial timber can be produced under management.

CONSERVATIVE LUMBERING IN THE HARDWOOD FORESTS OF ALLUVIAL BOTTOMS.

River bottomlands in east Texas are in too great demand for agricultural purposes to afford any prospect of permanent management by private owners beyond the supply of local needs by woodlots. Immigration is setting in at a rate that will result in the rapid clearing of the land; in many cases the forest is being destroyed simply to make way for farms. (See Pl. III, fig. 1.) The present stand contains vast quantities of superior hardwoods, and offers an excellent opening for large lumbering concerns.

It would be decidedly to the advantage both of the present owners, who have now no adequate market for their timberlands, and of the public, which would be benefited by the utilization of this valuable timber resource, if the capital necessary to harvest the crop could be induced to enter this somewhat neglected field; and it is to be hoped that better information of its amount, location, and value may be spread abroad. But the best eventual use for most of the land is plainly the production of field crops, except where the forest is needed for protection against erosion and to safeguard the water supply, and its preservation for the latter purposes should come not from private but from State action.

CONSERVATIVE MANAGEMENT OF WOODLOTS.

The application of certain principles of forest management on a small scale by farmers and ranchmen has large possibilities of usefulness, both public and private. The field for this is a very different one from that open to large concerns organized for the management of extensive forests. The latter can operate permanently only where great tracts of timberland exist which can not profitably be farmed. But even in the most fertile regions it is seldom that a farm contains no patch, large or small, which could not profitably be kept as a



FIG. 1.—LONGLEAF PINE LAND OVER EIGHT YEARS AFTER LOGGING; LITTLE OR NO PROGRESS TOWARD REFORESTATION ON ACCOUNT OF FIRES AND GRAZING.



FIG. 2.—LONGLEAF PINE LAND IN JASPER COUNTY IMMEDIATELY AFTER LOGGING OPERATIONS, SHOWING WASTE AND DÉBRIS, AND THE AMOUNT AND CONDITION

woodlot, and in the great majority of cases there is some hill or slope or ravine where timber growth would furnish valuable protection against soil erosion.

The advantage to the farmer of raising his own timber and fuel supplies is, as a rule, as self-evident as that of raising his own meat and vegetables in addition to staple crops. In the Lignitic Belt, in hilly central Texas, and along the streams of the central prairie region, the welfare of the community as a whole positively demands that a large percentage of timber growth be permanently maintained. This end could be secured if every farmer and ranchman would preserve the timber covering on the land he could well spare from cultivation. And the preservation of the timber is entirely compatible with its productive utilization by the owner *if a proper plan of management is adopted*. But the latter condition is just as essential in the case of the small owner as for the management of large forests in the pine country.

In many localities—in the case of cedar and pine lands, and on river-bottom farms where large oaks, ash, hickories, walnut, and the like now occur—the farm timber tract is capable of being made to yield still larger returns by the production of marketable timber.

FOREST EXTENSION.

The preservation of timber on areas where it occurs naturally requires little consideration of what species are to be raised or how to plant them. The establishment of tree growth on land not naturally timbered is a very different matter. In the former case nature has already furnished the answer to the question what kinds of trees will flourish; man has only to select. In the latter case the conditions must be carefully studied, and oftentimes painstaking experiments must be carried on with trees introduced from other and perhaps distant regions, to discover the right kinds and the way to make them grow.

The great diversity of climatic conditions in Texas presents very different problems in different parts of the State. The two chief factors in these problems are moisture and temperature. The absence of timber is due primarily to lack of rainfall. This is true of the Red Beds, the Staked Plains, the lower Rio Grande Plain (i. e., the Coast Prairie west of the ninety-eighth meridian), and, in general, all of Texas west of this meridian. In all these regions irrigation would be necessary at least part of the time. East of the ninety-eighth meridian there are large areas of treeless prairie with an annual rainfall sufficient to support certain kinds of trees. Such are the Grand Prairie, the Black Prairie, and the Coast Prairie east of the ninety-seventh meridian.

This region is capable of supporting a large and varied timber growth. The possibilities of tree growth in the Black Prairie, and particularly in the Coast Prairie country from Victoria eastward, are far greater than is generally believed, and the introduction of exotics which flourish under similar climatic conditions elsewhere will eventually furnish material additions both to the beauty and to the economic resources of the region.

In the region west of the ninety-eighth meridian the prospect is not so good. On the Staked Plains and in the lower Rio Grande country, where wells furnish the water supply, the limit of plantations will be set by the expense of raising and distributing the water. But on the plains only those trees can grow which are sufficiently hardy to endure a temperature of 10° to 20° below zero, while in the lower Rio Grande country the list of possible trees includes practically all which can grow in northern Florida, the San Joaquin Valley in California, and many of the lands which surround the Mediterranean.

CONCLUSIONS CONCERNING PRIVATE MANAGEMENT.

It is plain from the survey of the prospects of private management of forests in Texas that, in spite of conditions favorable to its practice in many parts of the State, and in spite of the hopeful beginning which has already been made toward introducing it in the longleaf pine territory, unaided private initiative will not suffice to protect the public interests affected by forest destruction. Under the lumbering methods now employed the pine forests are either ruined or so severely injured that their productiveness is greatly impaired. On the longleaf pine lands reforestation under present conditions is practically impossible. On loblolly and shortleaf lands reforestation is rapid enough, but the pine is for the most part replaced by scrub oak thicket. Fires and taxes remove the inducement to the forest owner to cut with reference to subsequent crops. The owners of small tracts and woodlots lack the knowledge required to make the most of their holdings. Communities dependent on the maintenance of forest cover for their water supply, or for protection against floods and silt, are exposed to the consequences of deforestation by landowners at a distance, acting solely with reference to their own interests. Left to themselves, the forces now at work will result in an impoverishment of the resources of the State which it will soon be too late to prevent, and will produce conditions necessitating remedial measures at very heavy public expense.

FOREST MANAGEMENT AND THE STATE.

State action to protect its forests may be (1) by promoting management by private owners, and (2) by itself undertaking the management of forests on State lands.

PROMOTION OF PRIVATE MANAGEMENT.

The main difficulties in the way of the introduction of private management on an extensive scale and in all parts of the State where forests of commercial value grow, are:

(1) *Protection against fire.*—This is of special importance in the longleaf belt, the chief seat of the lumber industry of the State. At present the renewal of the forest is made impossible by the fires which periodically burn the forest grass and litter and destroy the seedlings. But protection is difficult for the private owner, who is exposed not only to fires originating on his own tract, but also to those which invade it from his neighbor's lands. To maintain an efficient fire-fighting force would usually involve a prohibitive expense. It is possible that something might be done in the way of fire protection by the organization of State fire wardens or a forest patrol, particularly if the expense could be reduced by employing local officials already intrusted with other duties. But the only really effective way of controlling fires is to keep them from starting. The forests do not begin to burn up of themselves. While it is true that lightning has been known to originate forest fires, the proportion of fires from natural causes is so small as to be negligible. It is from those of human agency that the forest needs protection. To secure this a strong, enlightened public sentiment is needed. In a community which regarded setting fire to a man's woods as seriously as setting fire to his barns the problem of fire protection would be reduced to insignificant proportions. There is no more important work for the State to do in protecting its forests than to educate public opinion in the matter of fires.

(2) *Taxation.*—Forest management, which involves holding cut-over lands for a long term of years without return, is impossible in the face of high taxes. To tax forest lands on the same principle as agricultural land is simply to put a premium on destructive lumbering. Even if the valuation is put low enough not to be in itself inequitable, the necessity of paying taxes annually on land recently cut over, which will yield no revenue as timberland for many years, is a discouragement to all holders not possessed of large capital. Taxation based on the value of the standing timber, or taxation of the crop when harvested, would be at once more wise and more just than a tax levied at a constant annual rate.

(3) *Theft.*—The same unfortunate sentiment which permits setting fire to forests operates also as a source of loss to the owner by a more

or less sporadic cutting of timber without his consent. The pine lands of Texas are not unique in this respect, but here as elsewhere has harbored that unfortunate type of woods dweller who feels that he has an inalienable right to depredate upon the forest property of the larger, and especially the nonresident, owner. Here, again, it seems more a question of developing an enlightened conscience and a disapproving public sentiment than of combating a positive criminal tendency, but it must be understood that a man's forest property has the same protection against the trespasser and depredator as has his immediate residence property.

(4) *Losses by disease and injurious insects.*—At present the loss of timber from “red heart”—a fungous disease—is a very serious matter for the timber owner. Scientific investigations into the causes of damage to timber, and of possible preventive measures, may effect a great saving and proportionately stimulate private management by increasing the yield. Such investigations are for the public benefit, and may well be undertaken at public expense. It is not to be expected that the private owner will undertake them for the public good.

WHAT THE STATE CAN DO FOR PRIVATE MANAGEMENT.

The State can further the practice of forest management by private owners by (a) legislation, (b) education, (c) police protection, (d) investigation of forest problems.

(a) The taxation of forest lands, timber stealing, and forest fires should be considered with reference to existing laws and the possibility of improving conditions by their modification or by the addition of new laws.

(b) Information concerning paying methods of management should be diffused, public interest in the preservation of the forest as an economic resource should be awakened, and a healthy sentiment concerning the necessity of care to prevent fires should be built up.

(c) Proper officers should be charged with the definite duty of detecting and punishing those who steal, or wantonly, maliciously, or for their own advantage injure or destroy timber, and the most efficient protection possible should be devised for this form of property.

(d) It is worth considering what the State can do to secure, either through experiment stations or by cooperation with institutions capable of conducting the necessary researches, or with the aid of the Bureau of Forestry of the U. S. Department of Agriculture, scientific study of such questions connected with forestry as are likely to yield valuable practical results.

To devise and direct a permanent policy along the lines suggested, the establishment of a State forest board or commission would be desirable.



FIG. 1.—TYPICAL SWAMP FOREST ALONG THE NECHES RIVER NEAR BEAUMONT.



FIG. 2.—TYPICAL FOREST OF MIXED LOBLOLLY PINE AND HARDWOODS IN THE MARITIME BELT; WESTERN EDGE OF THE "BIG THICKET" COUNTRY IN LIBERTY COUNTY.

STATE MANAGEMENT.

The original State timberlands would have sufficed for a policy of State management on a large scale. Even after the various railway grants this might have been the case. But it has been the policy of the State to hold these lands available for purchase on mild conditions, so that when the yellow pine in particular found a wide market at good prices the State pine lands were in much demand. Either the land or the stumpage was sold. The greater part of the pine land now held by the State is cut-over land. During the past five years this also has been in demand, until the total has been reduced to an acreage too small and too scattering to make State management possible. This would now involve the acquisition by purchase or otherwise of additional lands. The same would be equally true of the shortleaf area and the Edwards Plateau. In all of these regions the topographic and soil conditions are such as to render imperative the maintenance by some agency of protective forests for the benefit of agricultural and other interests. The best argument for State management lies in this need of protective forests.

PROTECTIVE FORESTS IN THE LONGLEAF PINE BELT.

In parts of the east Texas region the retention of the pine forests is threatened by the sale of the land for farms. It is open to question whether agriculture can permanently succeed here; since it has failed on similar land in the Carolinas, which has been found too sandy and barren for crops.^a Immigration into the region is taking place at a rapid rate, assisted greatly by the oil boom and the demand for labor created by lumbering. The past two years have witnessed an influx of settlers literally by the car load. The rapid development of the country in this direction, together with the possibility of extending the present known area of oil production, has created a demand for the cut-over lands such that already some hundreds of thousands of acres have been bought up by large concerns or by individuals. Cut-over State lands, which were about the only timberlands left to its ownership in this district, have been included in these purchases. The State's interest as an owner is therefore not of great moment. The

^a The Bureau of Forestry is cooperating with the Houston Oil Company in the preparation of a working plan for the management of their timberlands, one of the objects of which is to outline a scheme of lumbering which will provide for the preservation of younger trees until all that now occupy the ground are large enough for high-grade lumber. If with State cooperation, an effective system of fire prevention can be carried out, of course the renewal of the forest from seedlings will be assured, and thus the continued productivity of the forest will be made possible. With this sort of cooperation between the State and private owners or corporations, the larger part of the longleaf pine lands might be kept as permanent commercial forests.

trend of land speculation at the moment is to transform these pine lands into farms and orchards and, where oil is indicated, into oil fields. If these circumstances continue there might seem to be little opening for forestry, the purpose of which is not to substitute a worse crop for a better one, but to secure the best use of all kinds of land. Not until it has been definitely established that the region is an agricultural one can this be decided.

Even if this is true, however, the dependence of the agricultural interests on the retention of a certain amount of forest growth in this region furnishes reasons for not abandoning the forest altogether to the play of the private interests directly concerned. It is a very serious question whether in the long run it would not be found to be a mistake to transform pine barrens as a whole into farm lands. There can be no doubt that the retention of forests on the rougher, poorer land would prevent deterioration of the better tracts by erosion and by the lessening of the water supply consequent upon a general removal of the forest.

It has been suggested in somewhat similar connections that perhaps sufficient protection would be afforded by the practice among private owners of reserving woodlots or larger timber tracts upon the poorer ridges or barrens. It will in any case be many years before the land is denuded of forest growth, and before the effects of forest removal will be felt upon agricultural operations. Meanwhile there is time for a campaign of education which would interest private owners in the rational practice of forestry on their own lands, at least so far as to protect their farms and raise their own timber supply.

There is, however, another point of view, which is that the State should by utilizing its present holdings, and by actual purchase of other tracts, establish a forest reserve in the longleaf pine area. Sound arguments for this course would seem to lie in the following considerations:

- (1) This longleaf area is capable of producing a continuous supply of high-grade timber, on the margin of a vast territory practically incapable of growing timber supplies of high grade.

- (2) A considerable proportion of the area is scarcely suited to the *continuous* production of anything except timber.

- (3) The better tracts, which would include especially alluvial bottomlands, would be benefited by the retention of forests on the poorer ones, especially upon the upland sand barrens.

- (4) The welfare of the community in the long run, subserved by retaining this valuable forest land, would offset the objection to the State's acquiring at considerable expense temporarily nonproductive land. Omitting the views of private holders immediately concerned, it is believed that the people of the State would be unanimous in their desire to see the longleaf pine area a permanent forest. This is not

to say that they would at this time indorse a proposition for the State to purchase and apply forest management upon such lands. That would mean such a radical departure from precedent and tradition in the State's activities as doubtless to encounter strong opposition.

(5) If the State should turn buyer and acquire pine lands enough to establish a forest reserve, it could place these lands under a well-devised plan of business management which would in a reasonably brief time be brought to a revenue-yielding basis. This would certainly be the case on those tracts where lumbering operations had left a fair stand of young timber. Such a course of management successfully carried out would be a most valuable object lesson to private owners, large and small, and might be expected to result in such an introduction of practical forestry on a large or small scale as would give the region a far greater value than would result from either an all-farm or an all-forest condition.

PROTECTIVE FORESTS ON THE EDWARDS PLATEAU.

Both the welfare of the Edwards Plateau itself and the welfare of the Coast Plain adjacent to it strongly demand the retention of a permanent timber covering on the plateau.

The relation of the Edwards Plateau to the Coast Plain between the Colorado and Devils rivers is like that of the Sierras to the valleys of central California, and of the Rocky Mountains to the adjacent plains in Colorado. Kings River and the San Joaquin River in California find their counterparts in the Guadalupe, San Antonio, and other rivers rising in the Edwards Plateau. In both cases the highlands furnish the water—in the former from snows, in the latter from springs. In both cases this water is both a boon and a menace to the country below. It is beneficial or destructive according to the rate at which it runs off the hills. Nature has placed a great reservoir high above the irrigated farms. The water is held back and distributed in even flow, not from a lake, but from the face of the country itself. On the Edwards Plateau the rock strata, exposed by erosion and dislocated by faulting, normally take up the water, which then percolates slowly to feed the steady-flowing streams. But to make this possible there must be a soil covering to hold the water when it falls. The plateau is a deeply cut up, mountainous area, with canyon-like valleys and highlands, thinly covered with soil. The rain comes in sudden cloudbursts, which, if not held back by forest growth, pours rapidly from the hillsides, carrying down soil and stones, and rushes off in destructive floods to inundate great areas of farm land below. The region is that of the arid Southwest, where agriculture without irrigation is uncertain. Destruction of the forest cover does not take away the reservoir; it opens the gates to pour the water down in successive inundations, instead of holding it in check until it is needed.

These hills, stripped of forest cover, become arid and worthless. On the sides and slopes of deep gorges which are heavily wooded there is found a deep accumulation of leafy humus. The cedar brakes also collect and hold large quantities of *débris*, and thus provide a covering several inches deep over the rocks. After the removal of the timber all this is rapidly washed away, and the restoration of the forest growth becomes impossible. Kept under timber, the land can be made to furnish a vast amount of material for posts, poles, ties, and rough construction purposes, as well as cheap fuel in a region where coal is very expensive. Yet there is little hope that the owners will preserve the forests. Small holdings are cut for the sake of the immediate profit. Large holdings are used chiefly as pasture lands, and the grasses flourish better without the timber. The country is primarily a cattle country, and cattlemen are apt to regard the timber as a nuisance rather than a benefit. All of the available timber is being cut as rapidly as it can be sold; in consequence, the steeper hillsides have become so denuded that natural reforestation seems impossible.

Manifestly this area needs a close covering. Fortunately, the forest type native to it is both dense and an energetic ground gainer. Many miles of old, stony pasture are growing up into thickets of live oak, cedar, elm, mountain oak, and shin oak; and on hills in Bell County and elsewhere from which a thick growth of mountain oak has been cut, an equally thick growth of cedar is taking its place. Timber tracts in the vicinity of Austin which were denuded twenty-five years ago are now heavily forested with cedar, which is again being cut, although immature. (Pl. IV.)

A forest policy which would recognize both the welfare of the hill country and its economic relation to the Coast Plain could be carried out only by the State. This would involve the purchase and reservation of timber tracts. But the price of the land which ought to be forest reserve is so low, and its value for any other purpose is so small, that the expense of such a measure would not offer serious difficulties in the way of its execution.

PROTECTIVE FORESTS IN THE LIGNITIC BELT.

The elevation of the Lignitic Belt, which has permitted erosion, has resulted in a rough, broken country. The soils are loose and sandy, and but for the presence of the shortleaf and post oak forests would be washed in great quantities from the steeper slopes. Such soils have little capacity for retaining moisture. Annual plants of superficial root system can not flourish in them without abundant rainfall. A seasonal precipitation which would amply suffice for maturing crops in the compact, waxy soils of the Black Prairie to the west of the Lignitic Belt would in the latter, but for the forests, have the



FIG. 1.—COW OAK TIMBER (*QUERCUS MICHAUXII*) ON THE TRINITY IN LIBERTY COUNTY.



FIG. 2.—ALLUVIAL BOTTOM FOREST ON THE TRINITY IN LEON COUNTY.

effect of a drought. The forests, with their leafy litter and intermixture of humus, change the character of the soil sufficiently to raise the water level. Their removal would be followed by the washing away of the débris, loss of the organic matter from the soil, and a consequent sinking of the water level to a depth which would seriously affect the flow of springs and streams, as well as the crops. The result would be to make dry seasons, like that of 1901, far more disastrous and more common than they have been in the past.

It does not follow from this that clearing for agriculture should be restricted. The amount of heavy timber throughout the Lignite Belt is so great and the land reforests itself so vigorously that danger from forest destruction is not at all imminent. In time, all of the land which can be brought into successful cultivation will be farmed. But there is much land which is too poor for permanent cultivation. The tendency in the region is to regard the timber as a nuisance, owing to its constant fight for possession and readiness to encroach. But for the good of the farms the poorer land on hills and high slopes should be kept timbered.

Under State ownership the quality of the forests needed for protection in this region would be greatly improved. It has already been said that there is no opening here for private management on a large scale to raise commercial timber. The heavy pine forests have been for the most part cut; more than half the area has no pine at all, and the prevailing upland oaks are of no value except for fuel and farm timber. State management, the occasion for which exists primarily in the fact that the interests of the community as a whole call for protective forests, would make possible a farsighted plan to secure the gradual replacement of the more valuable shortleaf pine. In this way the State would eventually have a large reserve area, which, besides being protective forests, would yield a revenue from the sale of valuable timber.

PROTECTIVE TIMBERLANDS ALONG WATER COURSES IN THE PRAIRIE REGION.

Unfortunately for Texas, her larger rivers have their sources in the arid plains at the base of the Rocky Mountains, where a protective timber growth is impossible. Several hundred miles of their upper courses run through treeless plains, upon which rainfall comes in sudden downpours amounting often to cloudbursts. Apparently, by far the larger part of the water so falling runs off in stream floods, carrying along enormous amounts of washed soil. The characteristic chocolate-colored floods rush away to the lower levels of the Coast Plain, where the slight fall in the water courses allows them to spread out over the valley, and when, as not infrequently happens, the streams

are already filled from local rains, the destruction is widespread. This happened in the Brazos flood of July, 1899, in the Colorado flood of April, 1900, when the Austin dam was carried out, and again in the Brazos flood later in the spring of the same year.

It is the opinion of many who have observed the recurrence of these floods for many years that they are growing in volume, if not also in frequency—a state of things quite to be expected from the breaking up of the protective grass covering by overpasturage along the upper courses of the rivers. Those who have ever seen the luxuriance of this grass vegetation will appreciate how great an influence it had in checking the run-off water and allowing it to sink into the soil. If this cover could be restored, the upper prairie region would be as efficiently protected as it could be by any timber vegetation capable of being established there.

It is in the middle courses of these streams, and on their numerous tributaries here, that a protective timber covering is needed. This is in the region of the Black and Grand prairies and the Carboniferous area westward. We have already seen that within this region we have the post oak of the Cross Timbers and the Carboniferous area, the river bottom timber, and the cedar and other species on the hills and bluffs along the river courses.

The value of this timber as a protective covering must be apparent from what has already been said. Its value as a source of local fuel, fencing, and other construction supplies has long been appreciated, because of the position of the region on the border of the endless stretches of untimbered prairie. Under these conditions, it is the opinion of the writer that the maintenance of the timberland here may be left to the cooperation of the farmers and ranchmen who own the land. Their own welfare will suggest it. There is needed only a campaign of education on the part of the State and Federal Government to cultivate a sentiment lively enough to lead to action, and to diffuse information as to how to act in the matter.

CONCLUSIONS.

The forest preservation which the interests of the State of Texas as a whole demand can be obtained only by the adoption of a definite State policy. Such a policy, to meet fully the needs of the situation, ought to include not only the fostering of private management, but also the establishment of State reservations. It ought to be conceived and administered on such permanent lines as to assure stable conditions to those whose cooperation is necessary. It ought to be at once scientific, availing itself of the best technical knowledge obtainable, and practical, adjusting itself to existing conditions and finding its support in the confidence and respect of the people with whom it must

deal. Its broad success will depend, not on its embodiment in legislation, but on its acceptance by the community at large.

The formulation of such a policy can best be brought about by the creation of a State board or commission. Such a commission might properly examine the workings of existing laws which affect the forests, and recommend changes or additions; arouse public interest and disseminate information concerning forest preservation; investigate the practicability of making reserves, and the area which might be included; and by cooperation with the Bureau of Forestry, or through such other means as it might find, secure the study of such scientific problems and the carrying on of such experiments as have an economic bearing on questions of forest utility in Texas. To this commission would also naturally fall the administration of the State reserves, should such be created by the legislature.

LIST OF VALUABLE TIMBER TREES NATIVE TO TEXAS, WITH NOTES ON THEIR DISTRIBUTION, HABITS, AND USES.

The following list is partly based on the writer's personal knowledge, partly compiled from such trustworthy publications dealing with the subject-matter as are available. Chief among the authorities which have been made use of are Sudworth's Check List of Forest Trees of the United States, Pinchot and Ashe's Timber Trees and Forests of North Carolina, and Havard's Botany of Southern and Western Texas. The first of these has furnished the basis of the list itself, with the ranges of the trees. The notes as to qualities, uses, etc., are derived largely from the second, while most of the notes on trees found west of the Pecos River are taken from the third. It is not to be supposed that the list is complete, and the information concerning the silvicultural characters, the distribution, and the number of the various trees is all too meager; but, in the absence of fuller knowledge, these notes may at least serve the purpose of a starting point for more exhaustive studies.

Limber pine (*Pinus flexilis* James).

In Texas the limber pine occurs only in the Guadalupe and Davis mountains, where it reaches a diameter of 12 to 18 inches. It yields inferior lumber.

Range.—Rocky Mountain region from Montana to western Texas; in mountains of northern Arizona, Utah, Nevada, and southern California.

Piñon, nut pine (*Pinus edulis* Engelman).

The piñon, or nut pine, is common to the Guadalupe, Davis, Organ, and Chisos mountains. It is also found on the higher ridges of the Great Bend of the Rio Grande as far north as the Southern Pacific

Railroad, on the forks of the Nueces River, and along the edges of the high plateau of the Staked Plains. In the Chisos Mountains, which it occupies almost exclusively, it becomes a tree with straight trunk 1 foot in diameter, and could be sawn into useful lumber of fair quality. It reaches about the same proportions in the Davis and Organ mountains. Elsewhere it is seldom large enough for anything but fuel and fence rails.

Range.—From Colorado (eastern base Pikes Peak) through New Mexico and to western Texas.

Western yellow pine (bull pine) (*Pinus ponderosa scopulorum* Laws.).

The bull pine occurs on the higher slopes and in the upper canyons of the Guadalupe and Davis mountains. It is the prevalent and most valuable pine of these mountains, with a trunk 1 to 2 feet in diameter. The wood is hard, heavy, and durable, making excellent lumber and very good fuel.

Range.—From the interior of British Columbia, south of latitude 51, and the Black Hills region of Dakota, southward in the Pacific and Rocky Mountain regions to western Texas and Mexico.

Loblolly pine, old field pine (*Pinus taeda* Linnæus).

In Texas the loblolly pine occurs chiefly on the interior margin of the flat, low coast plain, from the Sabine River to Houston and northwestward. Here, on sandy knolls, it forms dense forests of large growth. On the lower, more compact soils it occurs in mixture with hardwoods. It bears seed in abundance, apparently every year, and is here, as elsewhere, aggressive in occupying old fields or clearings. The wood is light, not strong, brittle, very coarse-grained, and not durable. In color the heartwood is light brown, the very thick sapwood orange, or often nearly white. In Texas the saw products are sold as yellow pine lumber.

Range.—From Delaware to Florida and Texas, generally near the coast, and north to the valley of the Arkansas River. It reaches its best development in eastern North Carolina.

Shortleaf pine (*Pinus echinata* Mill.).

Occurs from the eastern border of Texas to Anderson and Madison counties, over an area of some 30,000 square miles. It occupies the higher interior portion of the Lignitic formation north of the longleaf area. Large tracts of pure forest formerly existed in Marion, Cass, and Bowie counties, but these have been largely cut out. Most of the area now contains pine in mixture with post oak and other upland oaks. It attains dimensions here equal to those in the region of its best development—3 to 4 feet and more in diameter, and 70 to 90 feet high. The wood is heavy, hard, strong, and generally coarse-grained, and is orange in color, with nearly white sapwood. As lumber it is inferior only to longleaf pine.

Range.—From Staten Island, N. Y., to Florida and Texas, through Arkansas to Indian Territory, Kansas, and Missouri, and in Illinois. Its best development is in Louisiana, Arkansas, and Texas.

Longleaf pine (*Pinus palustris* Mill.).

In Texas the longleaf pine area includes about 5,000 square miles east of the Trinity and interior to the coast prairie and the loblolly belt. It prefers the low sand ridges of this region, though much of it occurs on flat, poorly drained soils. In four years during which it was under observation by the writer, it seeded abundantly once, though a fair amount of seed is produced every year. Seedlings and saplings are generally absent from the forest; they are killed out by fire or excluded by shade from the old trees. Much damage is wrought by fungi, which cause "red heart" and doty wood. Old timber suffers little from fires.

This is the most valuable of all American pines for heavy construction timbers, and the best of the yellow pines for all kinds of lumber. The annual Texas product exceeds three-quarters of a billion feet.

Range.—The coast region from southern Virginia to Florida, and thence to eastern Texas. It reaches its best development in southwestern Louisiana.

Red fir (*Pseudotsuga taxifolia* (Lam.) Britton).

In Texas the Douglas spruce (known also as red fir, Douglas fir, red pine, etc.) occurs only on the higher slopes and in high canyons of the Guadalupe Mountains, where it is a large tree, next in prevalence and size to the yellow pine (bull pine). It grows to be from 30 to 50 feet high and from 1 to 2 feet in diameter.

Range.—From the Rocky Mountain region in the United States northward to central British Columbia, and on the Pacific coast.

Bald cypress (*Taxodium distichum* (Linnæus) Richard).

The cypress occupies, either as a fringe of timber or in considerable bodies, the swamps and bayous east of the Trinity, especially in the low coast country. Westward, it occurs occasionally along the banks of streams, reaching far into the canyons of the Edwards Plateau, where specimens attain 6 feet or more in diameter. Only in places difficult of access does the cypress remain uncut. The lumber is much on the market now as shingles and for finishing—especially for doors—as well as for larger construction. The wood is light, soft, close and straight-grained, not strong, compact, easily worked, and very durable in contact with the soil; light or dark brown in color, the sapwood nearly white.

Range.—From southern Delaware southward in the coast region to Florida, and thence westward in the Gulf coast region through Texas to Devils River, and northward through Louisiana, Arkansas, and

eastern Mississippi and Tennessee, southeastern Missouri, western and northwestern Kentucky, southern Illinois, and southwestern Indiana.

Red juniper, red cedar (*Sabina virginiana* (Linnaeus) Antoine).

The red cedar occurs in the alluvial valleys of the Brazos, Red, San Bernard, and other rivers. Here it grows in mixture with dense hardwood timber and shrubbery. Most of the better timber has been removed. What remains is being marketed as piling and telegraph poles. From Columbia, near the San Bernard brakes, about 100,000 cedar poles were marketed in 1900. Sticks large enough for piling are rare. The short, even sticks are sold for lead-pencil stock. The heartwood is a dull red.

Range.—Nova Scotia and New Brunswick to Florida, and west in Ontario to Dakota, central Kansas, and Indian Territory. The Rocky Mountain and western red cedar, hitherto called *Juniperus virginiana*, is a distinct species.

Mountain juniper (*Sabina sabinoides* (H. B. K.) Small).

The species occurs on limestone hills, often where very little soil exists. Its characteristic occurrence is in impenetrable brakes. The tree branches profusely from the ground, hence clear timber is rare. The wood is extremely durable and finds very general use as posts, poles, ties, sills, fences, and for all sorts of construction, and for fuel. The leaves are small and more compactly arranged than in the red cedar; bark of branches mottled with white and dark patches; wood brown in color. It is the most valuable tree of the semiarid hill country of Texas.

Range.—Especially abundant in the hilly Edwards Plateau country of central Texas, but also found on rocky hills and bluffs northward toward the Red River, and southwestward and westward as far as beyond the Pecos, and probably into Mexico.

One-seed juniper (*Sabina monosperma* (Engelmann) Small).

Occurrence in western Texas is not well defined.

Range.—From the eastern base of the Rocky Mountains of Colorado southward into western Texas, and from southern Utah to central New Mexico and Arizona.

Alligator juniper, thick-bark juniper (*Sabina pachyphloea* Antoine).

This juniper is found in moderate abundance in the Guadalupe, Davis, and Eagle mountains. It has a trunk from 1 to 2 feet in diameter, but is seldom more than 10 feet high. The wood is reddish, close-grained, and very hard and durable.

Range.—The tree occurs in southwestern Texas and westward on desert ranges of New Mexico and Arizona south of the Colorado River Plateau, in the mountains of northern Arizona, and in Mexico.

Black walnut (*Juglans nigra* Linnæus).

One of the valuable hardwoods of the alluvial bottoms of the north-eastern part of the State. Most of the available big timber has been marketed. On the upper Sabine the species attains large proportions. On the western margin of its range it is dwarfed.

Range.—From southern Ontario to Florida, central Alabama, and Mississippi, and westward through southern Michigan, Wisconsin, and Minnesota to Nebraska, Kansas, and in Texas to the San Antonio River. The tree reaches its best development in the rich bottomlands of southwestern Arkansas and Indian Territory and on the western slopes of the Allegheny Mountains.

Mexican walnut (*Juglans rupestris* Engelmänn).

A small tree, becoming shrubby, and of interest chiefly as representing the black walnut in the arid Southwest.

Range.—Along the streams in the Edwards Plateau region of central Texas, and westward into New Mexico and Arizona and southwest into Mexico.

Pecan (hickory) (*Hicoria pecan* (Marsh.) Britton).

The pecan is native on alluvial soils of river bottoms of the Trinity and westward to the Concho. It becomes a very large tree, 3 to 4 feet in diameter, but of medium height (40 to 60 feet), with a very broad spread of crown. The tree is much cultivated in the middle western counties. Nuts are produced in abundance once in two or three years, and find a ready market. The wood has in general the qualities of the other hickories.

Range.—From Iowa through southern Illinois and Indiana, western Kentucky, and Tennessee, to central Alabama and Mississippi; through Missouri and Arkansas, Indian Territory, western Louisiana, central Texas, and Mexico. It has been considerably extended by cultivation.

Bitternut (hickory) (*Hicoria minima* (Marsh.) Britton).

The occurrence of this hickory in Texas is not yet sufficiently determined.

Range.—From southern Maine and Ontario to Florida; west through central Michigan to Minnesota, Nebraska, Kansas, Indian Territory, and Texas as far as the Trinity River.

Water hickory (*Hicoria aquatica* (Mich. f.) Britton).

This tree is very abundant on low stream banks and bayous, especially near Orange. Its occurrence elsewhere is not determined. It is a small tree of minor value and not easily accessible.

Range.—From Virginia through the coast region to Florida; along the Gulf shore to Texas and northward to southern Illinois. The best development is on the lower Mississippi and Yazoo rivers.

Shagbark (hickory) (*Hicoria ovata* (Mill.) Britton).

In Texas this is the most valuable hickory; it occurs on alluvial bottomlands, attaining a diameter of 2 to 3 feet and a height of 60 to 80 feet. The wood is heavy, very hard and strong, tough, close-grained, compact, and flexible. It is light brown in color, with the thin and more valuable sapwood nearly white. It is largely used for agricultural implements, carriages, ax and tool handles, baskets, and fuel.

Range.—On rich hillsides and on sandy ridges from the valley of the St. Lawrence River to Michigan and southeastern Minnesota, southward to western Florida, central Alabama, and Mississippi, and westward to eastern Kansas, Indian Territory, and eastern Texas, reaching its best development west of the Allegheny Mountains.

Mocker nut (hickory) (*Hicoria alba* (Linn.) Britton).

Occurrence in Texas is not sufficiently determined, but it is said to be rather abundant on the rivers in the coast country—e. g., on the San Bernard—and to attain large size. Its use is the same as the shagbark hickory.

Range.—Ontario to Florida, and west to Missouri, eastern Kansas, Indian Territory, and Texas (Brazos River).

Pignut (hickory) (*Hicoria glabra* (Mill.) Britton).

In Texas this hickory is one of the upland hardwoods in the short-leaf and post oak areas of the Lignitic Belt. It appears to be rather common and only of medium size—50 to 70 feet tall and 1 to 2 feet in diameter.

Range.—This hickory occurs on dry hills and uplands from southern Maine to southern Ontario, southern Michigan, Minnesota, the eastern parts of Nebraska and Indian Territory, and south to western Florida and southern Texas. It reaches its best development in the lower Ohio basin.

Common cottonwood, necklace poplar (*Populus deltoides* Marsh.).

In Texas this cottonwood is found in abundance along the banks and often covering the first bottoms of streams, far out into the prairie regions. Its region of best development is in the Red River Valley, where it occurs near the stream in pure forest. Farther back, on the alluvial bottom, it is mixed with many other hardwoods, and attains a height of 100 to 150 feet and a diameter of 4 to 8 feet. It is now extensively used for finishing lumber and for drawers, backs, and partitions in furniture. The demand for cottonwood lumber is increasing. The wood is very light, soft, not strong, close-grained, and compact; liable to warp and hard to season.

Range.—From Quebec and Vermont, through western New England and New York, Pennsylvania (west of the Alleghenies), Maryland, and the Atlantic States to western Florida, and west to the Rocky Mountains from southern Alberta to northern New Mexico.

Fremont cottonwood (*Populus fremontii* Watson).

Although not specifically determined, it is probable that the Fremont cottonwood takes the place of the common species west of the one hundredth meridian in Texas. Cottonwood of large size occurs about springs and in watered canyons in all of west Texas and up the Rio Grande to El Paso. In some of the side canyons of the Rio Grande it has been found as large as 5 feet in diameter. The wood of the western specimens—presumably the Fremont cottonwood—is of finer quality than the eastern, and is higher priced.

Range.—Western California to Lower California, and eastward to central Nevada, southern Utah and Colorado, western Texas, and Northern Mexico.

River birch (*Betula nigra* Linnæus).

In Texas the river birch is one of the river-bottom species, frequenting especially the higher river banks. It does not appear to reach large dimensions, but information as to its occurrence is meager. The wood is used for furniture, woodenware, wooden shoes, ox yokes, turning, etc.

Range.—Massachusetts to Florida, and west to Nebraska and to the Trinity River in Texas.

Hornbeam (*Ostrya virginiana* (Miller) Koch).

The hornbeam is rather abundant in the river bottoms of the loblolly belt and Big Thicket country, but does not often exceed 1 foot in diameter. The wood is heavy, very strong, hard, tough, very close-grained, compact; light brown in color, or often nearly white, like the sapwood. It is used for posts, levers, mill cogs, wedges, mallets, and the handles of tools.

Range.—Nova Scotia to northern Florida, and west to Dakota and eastern Texas.

Ironwood, blue beech (*Carpinus caroliniana* Walter).

Abundant and well developed in eastern Texas. It is known especially in the Big Thicket country. It prefers thick, shady woods and wet, alluvial soils. The wood and its uses are much the same as of the preceding.

Range.—Much the same as that of the hornbeam.

Beech (*Fagus atropunicea* (Marsh.) Sudworth).

The beech is common along the east Texas streams except where the ground is swampy. It appears to average 40 to 60 feet in height and 1 to 2 feet in diameter. The wood is not used here.

Range.—Nova Scotia to Lake Huron (north shores) and northern Wisconsin; south to western Florida, and west to southeastern Missouri and eastern Texas (Trinity River).

Chinquapin (*Castanea pumila* (Linnaeus) Miller).

Data are wanting as to the abundance of chinquapin in east Texas, but in certain localities (e. g., near Nacogdoches) there are groves of trees of large size. Nuts are commonly produced in abundance, and find a good market.

Range.—From southern Pennsylvania to northern Florida and eastern Texas (Neches River).

White oak (*Quercus alba* Linnaeus).

The identity and occurrence of the true white oak are not determined for Texas. White oaks there are in great abundance, but those examined by the writer are not *Q. alba* Linnaeus.

Range.—From southern Maine to Florida, and west to Nebraska and Texas.

Post oak (*Quercus minor* (Marsh.) Sargent).

This is by far the most abundant oak in Texas. It occupies gravelly clay or sandy upland soils in the Lignitic Belt, extending southwestward along the Fayette Prairie formation to Carrizo Springs. The "Cross Timbers," composed of this species, are found in the granite and carboniferous areas of central Texas to the one hundredth meridian. The post oak forest is heavy in east Texas, open and orchard-like westward. Eastward it attains a normal height of 60 to 80 feet and diameter of 3 to 4 feet. Westward the height is from 30 to 50 feet and the diameter 1 to 2 feet.

In all of the drier parts of its Texas range the post oak is likely to be diseased. Doty wood caused by fungous growth and dwarfed and misshaped limbs are common. The wood is durable in contact with soil, and has been used for railway ties and local construction. Great quantities are consumed as fuel, both in the timber belt and in the towns and cities of the Black Prairie. Elsewhere the wood is said to be used for cooperage, shipbuilding, and carriage stock.

Range.—Widely distributed over the eastern half of the United States.

Bur oak, mossy-cup oak (*Quercus macrocarpa* Michaux).

This is a very abundant and valuable tree in east Texas, where it attains a height of 100 feet and a diameter of 3 to 4 feet on the rich, alluvial river bottoms. On the lower Trinity and San Jacinto it is common. It occurs sparingly in the canyons of the Edwards Plateau, where it reaches a good size, considering the aridity. The wood of the bur oak is heavy, hard, strong, compact, and very durable in contact with the soil. It is used in shipbuilding, cooperage, furniture, etc., and is said to be the equal of white oak for these purposes. In Texas much of it has been used for railway ties and staves.

Range.—Eastern North America from New Brunswick and Nova Scotia to Pennsylvania, west to Montana (east base of Rocky Mountains), and southwestward into Texas to the Nueces River.

Overcup oak (*Quercus lyrata* Walter).

In the Red River Valley above Texarkana the overcup oak is the most common of the large trees. In some places it stands almost in pure forest. Specimens reach 100 feet in height and 3 to 5 feet in diameter. In the southern half of east Texas the tree is very common. It prefers wet, rich alluvial soils. In 1901 it bore acorns in great abundance. The wood has the qualities of white oak, and is used for the same purposes. The Texas product has been used for ties and staves.

Range.—In wet soils from Maryland to western Florida, and westward to the Trinity River in Texas. It reaches its best development in the valley of the Red River and adjacent portions of Arkansas and Texas.

Cow oak (*Quercus michauxii* Nuttall).

The cow oak occurs most abundantly on the San Jacinto River and its forks, and is generally abundant in the coast plain forest, especially in the "Big Thicket" country. It thrives in wet, alluvial soils, but not on swampy soil. It reaches 5 and 6 feet in diameter. This is a white oak somewhat similar in appearance to *Q. alba*, with wood much of the same quality and suitable for the same uses.

Range.—From Delaware to northern Florida; west through the Gulf region to Texas (Trinity River), and through Arkansas and southeastern Missouri to central Tennessee and Kentucky, Illinois, and Indiana.

Texas white oak (*Quercus pogonoxfolia* (Ell.) Ashe).

This species is very common in the lower coast plain forest on the San Jacinto and Trinity rivers. It is confused here with the genuine *Quercus alba*. In this locality the tree becomes 80 to 100 feet high and 2 to 4 feet in diameter.

Durand oak (*Quercus breviloba* (Torr.) Sargent).

This is one of the most abundant mountain oaks of the Edwards Plateau. The tree is small—20 to 30 feet high and 6 to 14 inches in diameter—but on the high divides it becomes dwarfed to a mere shrub whose aggregation comprises the "Shinneries" common in dry, hilly country. The wood is probably superior to post oak, but it is used mainly for fuel.

Range.—In the Gulf States from central Alabama across middle and southern Texas.

Live oak (*Quercus virginiana* Miller).

The live oak occurs in great quantity and perfection in the coast country from the Brazos to the Nueces (becoming dwarfed westward, however). It also extends northward well across the State on the Black and Grand prairies. The tree seems to prefer heavy, waxy clay soils, but it is found upon the river bottoms in the lower country.

The live oak here has usually a short, thick trunk and very broad crown. The trunk diameter reaches 5 and 6 feet, and the crown spread over 100 feet.

Range.—From Virginia, on islands and near the coast, to and through southern Florida and along the Gulf coast to western Texas. Also in Lower California, southern Mexico, Central America, and Cuba.

Small mountain live oak (*Quercus fusiformis* Small).

A form of Virginia live oak growing upon rocky, semiarid hills in the Cretaceous areas of central Texas.

Emory oak (*Quercus emoryi* Torrey).

Abundant in some of the canyons and along the southern base of the Davis Mountains, and forms the exclusive arboreal growth of some of the canyons of the Chisos Mountains. In the former habitat it is a handsome tree, with tall, straight stem, 1 to 3 feet in diameter. In the Chisos Mountains it seldom exceeds 12 inches. The wood is hard and valuable as timber and fuel.

Range.—Mountains of western Texas and of New Mexico and Arizona south of the Colorado plateau, and the mountains of north Mexico.

Texas red oak (*Quercus texana* Buckley).

The occurrence of the Texas red oak in this State is undetermined. It is the tallest and perhaps the largest of oaks.

Range.—The Mississippi Valley States from Iowa to Texas. The mountain form in Texas has been separated as *Quercus schneckii* Britton.

Mountain Spanish oak (*Quercus schneckii* Britton).

This is the most common oak in the Edwards Plateau region of Texas. It is a small tree, 5 to 10 inches in diameter and 20 to 30 feet high, occurring on the more stable slopes and hilltops. It often forms dense timber on sides of gorges, where by collecting much débris it aids the formation of rich soil, which it prevents from being washed away. The wood is good for posts and rails. It is much in demand locally for fuel, and all of the sizable trees are being cut. Acorns are produced in abundance, and young timber readily establishes itself.

Spanish oak (*Quercus digitata* (Marsh.) Sudworth).

This is believed to be the very common red oak of the sandy uplands in the shortleaf belt in east Texas. At Glendale and Nacogdoches, for example, it is very abundant and of large size, with very wide spread of crown. Its maximum height of 100 and diameter of 6 feet is closely approached here, though the average is smaller. The wood is heavy, very hard, strong, not durable, coarse-grained, and checks badly in drying. It is light red in color—the sapwood lighter. It is used for cooperage, construction, and very largely for fuel. The bark is rich in tannin.

Range.—From southern New Jersey to central Florida, and through the Gulf States to eastern Texas (Brazos River), Arkansas, southwestern Missouri to middle Tennessee and Kentucky, southern Illinois, and Indiana.

Black jack (*Quercus marilandica* Muenchhausen).

In Texas the black jack is common—often abundant—on all sandy clay or gravelly uplands. It reaches a height of 50 to 60 feet and diameter of 1 to 3 feet, but is smaller in the western part of its range. It accompanies the post oak in the Lignitic Belt, in its southwestward extension in the Cross Timbers, and in the granite and Carboniferous areas of central Texas, reaching to the one hundredth meridian. Eastward the tree is used only for fuel; westward it furnishes certain construction material for the regions in which timber is scarce.

Range.—Eastern United States, New York to Florida, and west to the one hundredth meridian.

Water oak (*Quercus nigra* Linnæus).

In Texas the water oak is very abundant along the bayous and in swampy bottoms as far west as the Colorado River. It attains in these situations large proportions, averaging probably 3 feet in diameter and 60 to 70 feet in height. The water oak has been used only for fuel and minor purposes. The wood is heavy, hard, strong, coarse-grained, and compact, rather light brown in color; the sapwood, lighter.

Range.—Southern Delaware to Florida; west to the Appalachian Mountains and through the Gulf States to Texas (Colorado River); northward to Arkansas, southern Missouri, Kentucky, and Tennessee.

Blue jack (*Quercus brevifolia* (Lamark) Sargent).

The occurrence and quantity of blue jack is not well determined. It appears to be one of the common upland oaks in the shortleaf pine belt.

Range.—From North Carolina (maritime belt) to Florida; west on the Gulf coast to Texas (Brazos River, and inland as far as Dallas).

Cedar elm (*Ulmus crassifolia* Nuttall).

In Texas the cedar elm is abundant along streams west of the Lignitic Belt, becoming a large and beautiful tree in the bottoms of the Colorado and Brazos rivers from near the coast through the Cretaceous regions. Here the height attained reaches 50 to 70 feet and the diameter 3 feet. In the Edwards Plateau country, cedar elm is common on the uplands wherever rich soil has collected, but here it is small—20 to 40 feet tall, and 8 to 12 inches in diameter. At Austin the wood is used for fuel. It is, however, inferior for this, but would probably be useful in turnery, woodenware, posts, and small timbers.

Range.—From Mississippi through southern Arkansas and Texas (from the coast to the Pecos River) to Mexico (Nuevo Leon).

Slippery elm (*Ulmus pubescens* Walter).

The occurrence and habits of this elm in Texas are not sufficiently determined.

Range.—Eastern North America from the lower St. Lawrence River to Florida, and west to North Dakota and Texas (San Antonio River).

American elm (*Ulmus americana* Linnæus).

In Texas the American elm is very common and of fair size along streams on the prairie, and in the Lignitic Belt it grows very large on porous sandy soils, even of the flat uplands, reaching a height of 80 to 90 feet and a diameter of 4 feet. The wood is heavy, hard, strong, tough, rather coarse-grained, compact, and difficult to split; the heartwood is light brown; the sapwood lighter. It is used for wheel stocks, saddle trees, flooring, and cooperage, and is exported for boat and ship building. In Texas the wood is used only locally.

Range.—Eastern North America from Newfoundland to Florida, and west to the base of the Rocky Mountains and to the Concho River in Texas.

Hackberry (*Celtis occidentalis* Linnæus).

In Texas, the hackberry is one of the commonest trees on the streams of the prairie region. It occurs both in the interior of the Lignitic Belt (northeast Texas) and on the uplands in the Cretaceous region (Edwards Plateau and northward).

At San Antonio and westward, the straight, short trunk ranges from 6 to 24 inches in diameter; on the lower Rio Grande it reaches greater proportions, being often 20 feet long and 2 to 3 feet in diameter, the total height being 50 feet or more. The wood is heavy, rather soft, not strong, coarse-grained, compact, clear light yellow; the sapwood, lighter. It is largely used for fencing and occasionally, since it takes a good polish, in the manufacture of cheap furniture.

Owing to its hardness, the hackberry has been much planted for shade on streets and in parks. With favorable, preferably deep alluvial or loamy soil and plenty of water, it makes a beautiful tree. Otherwise it is dwarfed and unsightly and much disfigured by leaf galls.

Range.—Eastern North America from St. Lawrence River to Florida; west to New Mexico and the Pacific Northwest.

Red mulberry (*Morus rubra* Linnæus).

The red mulberry is common in the heavy hardwood bottom forests of east Texas and in similar situations on the lower Colorado and Brazos rivers. The tree is only a small one, probably seldom exceeding 1 foot in diameter, and forms an inconsiderable item in the sylvia, so far as yet determined.

Range.—Eastern United States from Massachusetts to Florida and west to Nebraska, Kansas, and Texas (Colorado River).

Osage orange (*Toxylon pomiferum* Rafinesque).

Northeastern Texas, where formerly there were large quantities of very fine timber, is within the zone of best development of the Osage orange. Here it occurs on alluvial bottom soils, and attains a height of 60 feet and a diameter of $2\frac{1}{2}$ feet. The wood is hard, very strong, dense, and durable; in color, bright orange. Its weight per cubic foot is 48 pounds. It takes a fine polish and is very decorative, and could be well used in interior finish and cabinet work. No data are at hand at present to indicate how extensively it is so used in Texas. At Gainesville, much Osage orange, or "bodark" (bois d'arc), has been sawn into lumber. Much has also been shipped out for posts.

Range.—From southern Arkansas (south of Arkansas River) through southeastern Indian Territory and southern Texas to about latitude $36^{\circ} 56''$. It is widely distributed elsewhere by cultivation.

(Evergreen) magnolia (*Magnolia fatida* (Linnæus) Sargent; *Magnolia grandiflora* Linnæus).

In Texas the magnolia is very abundant and large in the half swampy lowlands of the coast belt. Here it reaches a height of nearly 100 and a diameter of over 4 feet. The wood is moderately hard, close-grained, not strong, easily worked, not durable in contact with the soil; creamy white in color; the thick sapwood nearly white. Although well suited for cabinetwork and interior finish, the wood is little used. Magnolia is one of the most promising of the hitherto unused Texas hardwoods.

Range.—Coast region of North Carolina to Florida, and westward in the Gulf coast region through western Louisiana to southern Arkansas and Texas (Brazos River).

Sweet gum (*Liquidambar styraciflua* Linnæus).

In Texas the sweet gum is very common, and attains large dimensions on the wet lower lands of the Lignitic Belt, occurring also to a considerable extent upon loamy uplands. It attains at least a height of 100 feet and a diameter of 4 to 7 feet on alluvial soils.

The wood is heavy, hard, not strong, rather tough, close-grained, and liable to warp and shrink. It takes a good polish and is used for cabinetwork, veneering, flooring, clapboards, barrels, and street paving. Sweet gum occurs in such size and quantity as to make it another of the promising trees among the unused Texas hardwoods.

Range.—From Connecticut to southeastern Missouri and Arkansas; south to Florida and Texas (Trinity River).

Sycamore (*Platanus occidentalis* Linnæus).

In Texas the sycamore is common on all the streams of the Lignitic Belt of the central prairie region, and in the Coast Plain from the Trinity to the Rio Grande and Devils River. It prefers the immediate banks of streams where these have cut through a considerable depth of

sandy clays or alluvium. The wood is heavy, hard, not strong, very close-grained, compact, difficult to split and work; brown in color. It decays rapidly in contact with the soil or on exposure, and warps and cracks badly in drying. It is used for ox yokes, butchers' blocks, interior finish, furniture, and very largely for tobacco boxes.

Range.—Eastern United States from New Hampshire to eastern Nebraska, and south to Florida and Texas.

Black cherry (*Prunus serotina* Ehrhardt).

Small specimens of black cherry are frequent along the gorges in the Edwards Plateau. There is no specific information as to its abundance in east Texas. Even the small trees are sought for by cabinetmakers.

The largest and best trees in all parts of the Eastern United States have already been cut.

Range.—From Nova Scotia to Tampa Bay in Florida, west to North Dakota, eastern Nebraska and Kansas, Indian Territory and Texas; also in southern New Mexico and Arizona, and in parts of Mexico and Central and South America.

Texas ebony (*Zygia flexicaulis* (Bentham) Sudworth; *Acacia flexicaulis* Bentham).

This is a shrub or small round-headed tree, with handsome evergreen foliage, and is common on the bluffs of the lower Rio Grande and Gulf Coast. Its straight trunk is seldom over a foot in diameter. The wood is heavy and compact, with the several shades of ebony, and taking nearly as fine a polish; hence its great value to cabinetmakers. Ebony posts are reputed the most durable of any made from Texas woods, and may be said to last forever.

Range.—Gulf coast of Texas (from Matagorda Bay) to Mexico (Sierra Madre Mountains in Nuevo Leon); Lower California.

Huisache (*Acacia farnesiana* (Linnaeus) Willdenow).

The huisache has come to be very abundant, both by cultivation and natural spreading, through the coast country from Galveston westward and as far north as Brenham and San Antonio. In many places it covers the coast prairie like a beautiful orchard. The trunk seldom exceeds a foot in diameter. The rose-colored wood is hard and compact, excellent for cabinetwork. Huisache posts rank next to those of mesquite in durability.

The huisache is one of the most promising species for cultivation in parks and residence grounds. It stands several degrees of frost easily. At Austin 3° below zero failed to kill several old trees in February, 1899. Near Galveston during the same freeze the spring was well started and the air moist; 8° above zero killed much of the huisache to the ground, but it has since grown out from the stumps.

Range.—Native in America from Rio Grande River to Northern Chile; also in Australia and subtropical Africa; naturalized in West

Indies, Guiana, Brazil, Argentina, India, Southern China, Indian Archipelago, and islands of the Pacific; widely cultivated and naturalized from the Gulf Coast region to southern California, and also in Mediterranean countries.

Mesquite (*Prosopis glandulosa* Torr.).

The mesquite varies in size with conditions, attaining a height of over 30 and a diameter of 2 feet in the lower Rio Grande Valley, averaging 20 feet high and 5 to 10 inches diameter on prairies in central Texas, where it has long been established, and reduced to mere switches on the lower half of the Staked Plains.

Its spread has carried some serious evils in its train, but on the other hand a great deal of fencing and fuel material has been gained, and a very considerable amount of forage.

The tree is of great general utility because of the hard, heavy, compact, and durable quality of the wood. It is used for posts, ties, paving blocks, underpinning, etc., and is an especially good fuel. It should be especially fine for cabinetwork. Other features which can be merely mentioned here are its yield of gum (like gum arabic), tannin, and nutritious bean pods.

Range.—Widely distributed through the arid southwest (Lower Sonoran zone) from about the ninety-seventh meridian in middle Texas to California, Lower California, and into northern Mexico; in the Andean region of South America to Chili, Argentina, and southern Brazil; also in the West Indies.

In Texas the mesquite has for fifty years been crowding up from the southwest and overrunning the prairies to the north and eastward, having passed beyond the Colorado—indeed, to the Brazos—in central and southern Texas, and along the foot of the plains to Oklahoma and even southern Kansas.

Black gum (*Nyssa sylvatica* Marsh.).

In Texas the black gum is very abundant on low, alluvial soils and even in water soaked, swampy places. The Red River bottom and Sulphur Fork have areas covered with almost pure forest of black gum, which attains a height of near 100 feet and a diameter of 3 to 4 feet. The wood is heavy, strong, soft, very tough, and hard to split and work; inclined to check and not durable in contact with the soil; light yellow or nearly white in color. It is used for wheel hubs, rollers in glass factories, ox yokes, shoes for horses in rice fields, wharf piles on the Gulf coast, and soles of shoes. The black gum has scarcely come into demand in Texas yet.

Range.—From Maine to Florida and west to southern Ontario, southern Michigan, southeastern Missouri, and eastern Texas (Brazos River).

Tupelo gum, cotton gum (*Nyssa aquatica* Linnæus).

The tupelo is abundant in the swamp and bayou type of forest, especially in the coast country east of the Trinity. It attains large dimensions—80 to 100 feet in height and 3 to 5 feet in diameter. The wood is light, soft, not strong, close-grained, compact, not wedgeable, and light brown or nearly white in color. It is used for turning, wooden ware, broom handles, and wooden shoes, and for vegetable boxes and crates.

A few lots of tupelo have been sawed in Texas to test its value and desirability for making cheap crates, boxes, etc.

Range.—Coast region from southern Virginia to northern Florida, west through the Gulf States to eastern Texas, and northward up the Mississippi Valley to southern Illinois.

White ash (*Fraxinus-americana* Linnæus).

In east Texas the white ash grows abundantly and of large size in alluvial river bottoms. It attains a height here of 100 feet or more and a diameter of 3 to 5 feet.

Most of the ash that stood near railways has been removed; also much has been rafted down the Trinity. The supply has been thus very much reduced. A relatively small amount has been consumed by local furniture factories.

Range.—From Nova Scotia and Newfoundland to Florida, and westward to Ontario and northern Minnesota, eastern Nebraska, Kansas, and Indian Territory and Texas (Trinity River).

Green ash (*Fraxinus lanceolata* Borkh.).

This ash appears to be abundant in eastern and southern Texas along the river bottoms, but the facts of its occurrence are not distinguished from the white ash. The wood is inferior in quality to that of the white ash.

Range.—In Eastern United States, from Vermont to Florida; westward to the eastern ranges of the Rocky Mountains and extending into the Wasatch Mountains of Utah and mountains of northern Arizona; in eastern Texas to the Colorado River.

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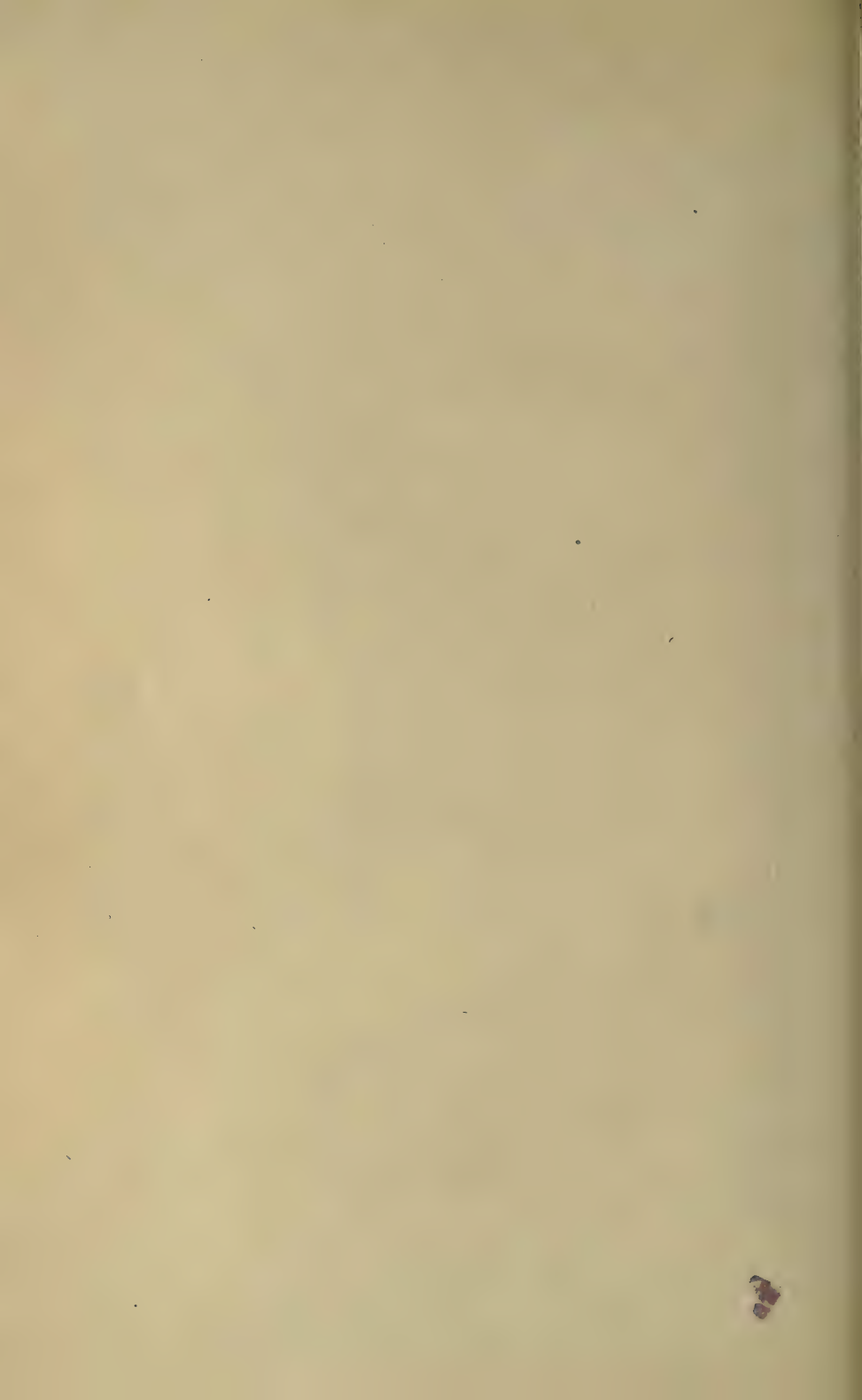
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The Trees of Texas

An Illustrated Manual of the Native and
Introduced Trees of the State

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston.

Cultivated mind is the guardian genius of democracy. . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar.

PREFACE

The present bulletin has been prepared to meet the needs of those persons who desire to become more familiar with our native and introduced trees, but who do not have access to the more complete sets of books which treat this subject. It has been my constant aim to avoid the use of technical terms, and only such have been introduced as can be easily learned from the glossary by the amateur student of nature who has had no previous training in botany. The scientific name and the common names most generally in use have both been given for each species. The keys for the separation of families, genera, and species are based, in so far as is possible, on the leaf characteristics. This is necessary for the reason that the leaves remain on the tree throughout the summer, while the flowers soon fall away. We should not be deceived, however, into thinking that leaf characteristics denote natural relationship to the same degree as the characteristics of the flower. It has sometimes been necessary to make use of other characteristics of the tree, such as the fruit, bark, or thorns in order to separate closely related genera or species.

The list of trees herein given has been checked from Sudworth's "Check List of Forest Trees of America", Britton's "North American Trees", and Sargent's "Manual of the Trees of North America." There will doubtless be a number of rare cultivated varieties that have been omitted.

The descriptions are based largely upon herbarium specimens deposited in the herbarium of the University of Texas. The collection of this herbarium material has extended over a period of fifteen years, and has been accomplished by the various persons who have been connected with the School of Botany during that time.

The drawings of leaf characteristics are taken from Gray's "Text Book of Botany" and have been used by permission of the American Book Company to whom the author wishes to express his indebtedness. The photographs for plates 1, 23, 3, 24, 5, are by Professor Wm. L. Bray, formerly Professor of Botany in this University, published by him in his "Forest Resources of Texas", and are here published with his permission. All other line figures have been drawn from herbarium or fresh specimens

by Miss Josephine Huppertz, a graduate student in the School of Botany of the University of Texas. The writer also acknowledges his indebtedness to the various published works of others. The notes of Mr. J. B. Mackenson of San Antonio, on the "Trees of San Antonio and Vicinity" and of Mr. Carl Hartman on "The Trees of Huntsville" have been freely used. The characteristics and uses of the various woods have been based, in part, upon a report of "The Wood Using Industries of Texas" by Hu Maxwell, Expert, and Charles F. Hatch, Statistician of the United States Department of Agriculture, Forest Service, published in the Lumberman's Trade Journal, New Orleans. The arrangement of the groups is essentially that of Engler and Prantl.

ISAAC MCKINNEY LEWIS.

University of Texas, School of Botany, February 6, 1915.

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INTRODUCTION

A tree is a woody plant which produces one main central upright axis or stem that does not branch for some distance above the ground. A shrub is also a woody plant, but its stem always branches directly at the ground. Some plants are either trees or shrubs, as, for example, the well known mesquite or the willows.

The tree, as a whole, is an active, living, working being, endowed with all the vital activities peculiar to plants, and sensitive to the physical and biological environment in which it lives. A tree is composed of stem or trunk, roots, leaves, branches, buds, flowers, fruit and seed.

The leaf is an expanded, usually flattened branch of limited growth, consisting of two main parts: the blade or expanded portion, and the petiole or stalk which connects the blade with the shoot. A pair of leaf-like appendages, known as stipules, are sometimes attached to the petiole. There is a wide variety in shape, size, form and structure of leaves, and it is on these characteristics that the key for the separation of the species is largely based.

The leaf performs three very important functions, namely: photosynthesis, transpiration and respiration.

The word, photosynthesis, means synthesis by means of light. In this process, the green, expanded portion of the leaf, in the presence of sunlight, unites carbon dioxide, which it receives from the air, and water, which it receives from the soil, forming a new compound, carbohydrate, and liberating oxygen, which escapes from the leaf into the atmosphere as a waste product. Thus the green leaf consumes a gas which cannot support combustion or be used in respiration by animals or plants, and releases one which can be so utilized. This explains the purifying effect of green plants on the atmosphere. This process is entirely dependent upon sunlight, and will not take place unless the leaf is properly illuminated. It does not occur any place in nature except in green tissue of plants, and a similar union of the crude materials, carbon dioxide and water to form sugar, has not been brought about, so far, by our most ingenious chemists.

The process of photosynthesis easily ranks as one of the most important of all vital processes, for upon it all life, animal as well as plant, depends. All living substance requires for its nutrition, carbon, for it is one of the essential constituent elements of such substance. But neither plants nor animals are able to utilize crude carbon dioxide as food. It must first be combined chemically with hydrogen to form sugar or starch before it can be so utilized. It is seen, therefore, that plants and animals are alike as regards their food requirements. They differ only as to the manner of procuring food. The plant is an independent organism which is able to manufacture its food from crude inorganic material, while the animal is ultimately dependent upon plants.

It is a well known fact, that when materials containing carbon, as for example, starch, oil, sugar, coal or wood, are burned, carbon dioxide is given off and energy is released in the form of heat. This heat energy was potential in the compound burned. The radiant energy of sunlight enables the green leaf to unite carbon dioxide and water to form carbohydrates, and becomes potential in the compounds formed. Its subsequent release, to do our bidding, depends upon the combustion of these compounds. The energy which furnishes the chief driving power of the world's machinery is energy from the sun, which has been arrested and rendered potential by the green leaves of plants. The coal which warms our homes, cooks our food, and drives our machinery, depended for its formation upon this function of the leaves of plants, which inhabited the earth at that remote age when coal was formed. The heat energy has remained locked up, potential in the carbon compound, awaiting an opportunity to again become kinetic.

The food substances which nourish plants and animals, furnishing them materials out of which their bodies are built, and energy with which to carry on their vital processes, depends upon this ability of the green leaf to unite carbon dioxide and water to form starch and store the radiant energy of the sunlight in a potential form. The release of this energy by a living plant or animal is accomplished by another vital process known as respiration.

If the ability of green leaves to carry on this most important

function in nature depends upon sunlight for its realization, we might well expect to find provision in the arrangement of leaves to facilitate an optimum light exposure.

This expectation is borne out by the facts, and can be easily verified by an examination of the leaves of a few of our native trees with this point in mind. One can not fail to be impressed with the wonderful adjustment by which each leaf on the tree is so placed as to bring it into just the proper exposure to light. Obviously, one of the great difficulties to be overcome is the danger of shading of the lower leaves by those growing above them. The leaf is in its best light relation, on most plants, when its blade is exposed at an angle of about ninety degrees, to the source of light and is free from the danger of being shaded. The exact arrangement of leaves on the stem is a constant characteristic for any plant. In some species the leaves are borne in pairs, one leaf attached on the shoot opposite the other. In this manner of attachment the pairs are arranged in such a way that when looking down on the stem from above there can be seen four distinct rows of leaves separated from each other by greater or less distance, depending upon whether the leaf blade is narrow or wide. In the great majority of trees the leaves are attached singly, and not opposite. This arrangement is called the alternate arrangement, and they are spaced in definite cyclic order upon the shoot in such a manner as to afford sufficient space between the lower leaves and the ones growing above them.

The blades of many leaves are variously cut, toothed, notched, lobed or compounded, and through these openings the light is enabled to filter down to the lower parts of the tree. It is not to be expected that every leaf on a tree can be so placed that it will be in its optimum light relationship at every minute in the day. This would only be possible if the leaf were able to swing about on its petiole and follow the daily march of the sun. When the leaf has reached maturity, its position is relatively fixed and its position with reference to light has been determined by the direction from which it was illuminated during the greater part of the day as it developed. It is, therefore, in the shadow during a part of the time only. Some plants require much more light than others, and many find their best conditions for growth in the subdued light of our deep forests. The shade loving habit of

the ferns, and of many herbs and shrubs, gives us the characteristic ground plants or undergrowth of the woodlands. Trees growing in open situations, where they are equally illuminated from all sides, are usually lower, more bushy topped and symmetrical than members of the same species which grow crowded together in forests. This is to be accounted for by upward growth of the stem, under the stimulus of light from above only. It usually happens, also, that the branches of trees growing close together die away from the older portions, resulting in tall naked stems with a crown consisting of a few branches at the top.

The second important function of leaves is transpiration, or the evaporation of water. The life of the tree depends upon the ability of the leaf to perform this function properly. The amount of water thrown off depends upon the structure of the leaf itself, and upon the physical environment in which the tree grows. The total amount of water transpired by plants is surprisingly great. It has been estimated that an oak tree with seven hundred thousand leaves would give off 244,695 pounds of water from June to October. A birch tree with 200,000 leaves transpired 700 to 900 gallons per day on hot summer days. An acre of such trees would, therefore, transpire 3,168,000 pounds of water in a single season. It is estimated that 200 to 500 pounds of water is transpired in the manufacture of one pound of dry substance. This accounts for the cooling and refreshing effect which vegetation exerts on the atmosphere. It is a well known fact that plants die if they are unable for any reason to take in a supply of water from the roots, sufficient to meet the enormous and continual drain from the leaves. This accounts for the disastrous effects which hot, dry winds exert on many species of plants, and raises the question whether such quantities of water as are ordinarily thrown off are an advantage or a disadvantage to the tree. The opinion is now widely held by botanists, that much greater quantities of water are thrown off by plants than is necessary for the carrying on of their vital activities, and that such great water loss is due to the fact that plants have not fully solved the problem of conserving water. In order for the leaf to carry on the process of photosynthesis, it must of necessity be provided with some means which will permit the entrance of air containing the necessary carbon dioxide, and the

removal of the waste oxygen formed during the process. This is made possible by numerous very small openings in the outer coat of the leaf tissue, known as breathing pores or stomates. It is thru these minute pores that all the gaseous exchanges take place, which make photosynthesis and respiration possible. These openings are therefore necessary for both of these processes. But it is also through them that the water escapes to the outside in the form of vapor, where it evaporates and is lost from the tree. It appears, then, that the functions of the leaf are somewhat antagonistic. It must be aeriated in order to carry on photosynthesis and respiration, but the provision for aeration is the source of the evil of excessive water loss. It should not be understood, however, that all water loss is a disadvantage. This is true only when it becomes excessive. Doubtless the cooling of the leaf on hot summer days, due to this evaporation of water, keeps the heat from destroying the delicate living substances which compose it.

It is evident that the condition of the soil and air in which the tree grows must determine, to a great extent, the amount of transpiration, since evaporation of water depends directly upon the temperature and the amount of water vapor in the atmosphere.

But the plant itself is not without devices to reduce the loss of water. The breathing pores are principally on the lower side of the leaf, while the upper surface presents, usually, an unbroken covering, which is coated with a waxy substance that does not readily permit the escape of water. Such waxy coverings of the leaf characterize trees which grow in dry situations where the evaporation rate is high, and doubtless have played an important part in fitting these trees to their environment.

The lower side of many leaves is covered with a more or less dense growth of hair-like outgrowths, which also serves to retard the evaporation of water. Such hairy coverings are almost always present on both surfaces of leaves when they first expand from the bud. They frequently remain throughout life or they may disappear with the development of the wax-like, water-proof coat which characterizes the mature leaf.

The size and number of leaves also bears a definite relationship to the environmental conditions. Trees growing in very dry, hot

regions are characterized by small leaves, which do not permit excessive losses of water, while trees growing in warm, moist localities bear numerous large leaves. Some trees bear leaves which are reduced to mere scales, and in some plants, as the cactus, the leaves have entirely disappeared, or have been reduced to small outgrowths known as spines. This is to be explained on the basis of water loss. Such plants grow natively in arid places, where they are fitted by nature to live, and where plants provided with structures which would not insure them against excessive transpiration, could not survive. The distribution of trees is determined largely by their adaptation to water, and this is in turn determined by the root and leaf characteristics.

The third function of the leaf is respiration or breathing. Respiration is a very important vital process which takes place in all living parts of the tree, and is not confined to the leaves alone. Unlike photosynthesis, it does not depend upon light. The gas consumed in respiration is oxygen, and the gas set free is carbon dioxide. It will be seen, therefore, that the plant breathes in exactly the same way as animals, consuming oxygen and liberating carbon dioxide. Respiration is the process in which energy, locked up in foods, is released. It is closely akin to combustion, but the two processes are not identical. The radiant energy from the sun enables the green leaf, in the process of photosynthesis, to decompose the simple inorganic compounds of carbon dioxide and water, and to recombine them into foods which represent a certain amount of stored or potential energy. Respiration breaks down the products of these foods and sets the energy free. Life involves always and continually these transformations of energy. The sun is the source of all life, for it is the source of energy. Photosynthesis utilizes carbon dioxide, and releases oxygen, thus keeping the air pure for breathing purposes. Respiration uses oxygen, liberates carbon dioxide, and sets energy free, and thus makes possible the vital phenomena requiring energy.

The roots of trees constitute the organs of anchorage and absorption. They anchor the tree firmly in the soil and absorb the water and mineral solutions from the soil. The roots are of two kinds, surface and tap, depending on their shape and depth of penetration. It may seem surprising that the roots are able to

absorb such great quantities of water as we have already seen are thrown off by the leaves in transpiration. But the extent of the root system is much greater than we ordinarily suspect, usually equaling or even surpassing in extent the spread of the branches. The roots of tree frequently penetrate the soil to great depths. This is particularly true of trees which grow in very dry soil. The roots of the mesquite are known to attain depths of sixty feet when growing under arid conditions.

The work of absorbing water is carried on by delicate hair-like outgrowths known as root hairs, which form near the tip of the root. These root hairs are fine and delicate, and attach themselves closely to the water-bearing particles of the soil.

Roots of trees are made up largely of woody tissue like the stem, and this enables them to serve as an avenue for the conduction of water as well as to give the trees a firm anchor in the soil.

Roots are sensitive to the pull of gravity, and are also attracted by moisture. The main central or tap root, if growing in soil equally moist on all sides and not hindered by any mechanical obstruction, takes a course straight downward, while the lateral or secondary roots branch out in all directions. Roots usually grow toward moisture. This may be observed along ditches or irrigation canals as well as on the sides of vertical cliffs. The sensitiveness of roots to water, and their ability to grow toward it has been of great advantage to plants. Trees which develop long tap roots are transplanted only with great difficulty. The pecan is a noteworthy example. To offset this difficulty, the tap root on young trees is sometimes cut by nurserymen and a mass of much branched roots of about equal size develops to take its place. The root system must be able to supply the water transpired by the leaves or the tree will die. Accordingly, in transplanting young trees the top should be cut back sufficiently to give the roots time to become established and develop their root hairs.

Roots are very useful in many places because of the binding action which they exert on the soil, thus preventing erosion. Such trees as willows growing along water courses, or the trees of mountain sides and hill slopes, furnish examples of this principle.

The stem may be defined as that part of the tree which bears the roots and leaves and serves as a connection between them.

The water, with its dissolved mineral salts taken up by the roots, passes up through the stem and its branches out into the leaves. The stem responds to the stimulus of gravity and light by growing away from the pull of gravity and toward the light. This response is exactly the opposite to that made by the root, and results in an elongated aerial organ whose chief function is to display the foliage leaves to light. The lateral branches of the stem, like the branches of the root, grow in various directions. The branches may be almost horizontal, drooping, or ascending. In the coniferous trees, such as the pines, the main stem does not branch equally, but extends upward through the crown to the top, and the lateral branches are arranged in regular whorls, which decrease in length from the base to the apex of the stem. Such trees form a more or less symmetrical, elongated, cone-shaped body, which affords the optimum exposure to light. Many of our deciduous trees also exhibit quite regular, conical-shaped crowns. The lombardy poplar, the sour gum, and many species of oak and maple furnish examples. In some trees the main trunk does not extend upward through the crown, but is soon lost and the crown becomes rounded or spreading; the bur oak, the hackberry and the American elm are examples of this type.

In transverse cuts across the stem or any of its branches, four distinct main parts may be observed: the central pith, the woody cylinder, the cambium or growing layer, and the bark.

The woody cylinder consists of a series of annual rings arranged more or less in concentric order. Each ring represents a single season of growth, and by counting the rings the age of the tree in years can be determined with almost perfect accuracy. The ring is made up of two layers, of which the thin, firm layer represents the fall growth, while the more porous large vessels develop in the spring and early summer. It sometimes happens that if growth is checked during the growing season more than one ring is formed, but this can usually be distinguished by careful examination. The outer layer of wood, the sap wood, is usually lighter in color and more readily subject to decay than the central layers or heart wood. This is due to the deposition in the vessels of the heart wood of various secretions which render them impervious to water and exert an antiseptic action on the organism of decay. The sap wood is the chief water-conducting avenue of the

stem, hence trees may be killed by cutting out a ring of this wood entirely around the stem, thus preventing the ascent of water.

The medullary rays radiate from the pith to the bark, and are seen in cross cuts as fine lines of varying widths. In longitudinal cuts, or when the wood is split lengthwise they are seen to be thin plates which differ in structure from the wood proper. The beautiful silver grain of quarter-sawed wood is due to these medullary rays. The rays transport material laterly in the stem and serve as a storehouse for reserve food substance principally in the form of starch.

The cambium is a layer of living tissue which occurs at the outer boundary of the woody cylinder. It is fine and delicate and separates the wood from the bark. It is due to the growth of this tissue that the tree increases in diameter from year to year. The woody cylinder is made up of dead tissues, but the cambium is alive and active, forming new wood on the inside and bark on the outside.

The bark is made up of two distinct layers, an inner and an outer bark. The inner bark is thin, white and fibrous, and has for its function the transport of plastic food substances from one part of the tree to another. If during the growing season the bark is removed just down to the wood, the tree remains alive for the remainder of the season, but dies the following spring. This is due to starvation of the roots, as there is then no way by which food from the leaves or stem can reach them. This principle is frequently made use of in the killing of willow trees and others.

The outer bark is made up of a layer of cork tissue which surrounds the stem and varies in thickness from a very thin papery layer on some trees to several inches in thickness on others. The bark develops from the inside out, and the outside layers are shed and fall away. The method of shedding the bark is quite variable among trees, but is relatively constant for any given species. In some species the bark is tight and smooth, while in others it becomes deeply furrowed or grooved and broken on the surface into smaller scales. The bark of the birch peels away in thin papery layers, the cedars become shreddy, while some of the hickories form large shaggy plates. An experienced

forester can usually determine the species of tree by the bark characteristic alone.

The function of the bark is to prevent loss of water and to protect the delicate inner living tissues from the entrance of parasitic fungi and bacteria which would lead to the decay and death of the tree. Injuries which break the continuity of the bark are the most frequent causes of diseases of trees. The gnawing of the bark by horses is one of the serious menaces to street shade trees, and they should always be protected against it. The bark forms a very effective protective layer which, if uninjured, usually suffices to keep most trees in a relatively healthy condition. It is, however, provided on young portions with openings which are necessary to furnish a means for aerating the stem. These openings are known as lenticels, and they furnish an unavoidable avenue for loss of water and for the entrance of fungi and bacteria.

A bud may be defined as an undeveloped shoot. The formation of buds takes place during the active growing season, which in our latitude lasts until the middle or latter part of July. After this time the tree continues to manufacture food and store it up in the buds and other organs until September or October, when a period known as the winter rest period begins. This lasts until the following spring, when the buds expand into leafy or floral shoots. This rhythmic periodicity in the life of the tree is directly due to the change of the season from conditions favorable to growth to conditions unfavorable.

The bud contains, in miniature form, the leaves or flowers which will appear the next year. These structures are very small, yet all the parts are present. The outer part consists of a series of leathery, scale-like leaves which overlap each other and protect the delicate inner parts from injury. It is a popular notion that the enveloping bud scales serve as a protection against cold and keep the inner parts from freezing during the cold winter. But this is not the case. There are in plants no provisions for maintaining a body temperature higher than that of the surrounding air, and there is no cold so intense that it could not be endured by many plants if this were the only unfavorable factor. The bud scales serve primarily as a protection against loss of water, for which purpose they are well fitted. The mucilaginous or

resinous material with which the scales are cemented together renders them almost water-proof and prevents the escape of water at a time when none could be obtained from the soil. In the spring, however, after the buds have begun to open, they are readily killed by freezing, for this draws the water out of the delicate inner parts, and the protection against loss of water having been now lost, the bud dies of dessication when the ice melts.

Buds may be grouped into various classes on the basis of structure, position on the stem, parts included, and time of development.

As a rule, buds are borne singly in the axils of the leaves; at the end of the stem or its branches; or directly underneath the petiole of the leaf. The bud may contain foliage leaves, flowers, or in some cases both. Many buds, because of their location, fail to develop and are known as dormant buds. They usually die within a few years, but in some cases they remain alive and become covered over with layers of wood, under which they grow slowly and maintain themselves near the surface of the wood. These buds, growing and branching in the wood, produce the curling and twisting of the grain, which is known as "bird's-eye" wood.

The dormant buds may begin to develop at any time, provided they are favorably located and supplied with sufficient food. This condition arises when part of the tree is broken or cut away and the young shoots that develop come largely from dormant buds. Buds may also arise at any time from the stem, root, or even the leaves. These are called adventitious buds. The frequent suckering of many plants from the roots is due to these adventitious buds, as is also the growth of sprouts from the stumps of hardwood trees.

The rapid unfolding of buds into leaf and flower is ever a constant source of pleasure, for it marks the transition from dormant to active life. It involves all the changes which take place in the great awakening of nature from its long winter sleep period, and inspires within us hopes of a promise to be fulfilled in leaf, flower and fruit.

The flower may be defined as the forerunner of a seed. All of our trees, when they have reached a certain age, bear flowers and develop seeds. It is this characteristic which enables each

species to perpetuate itself and to become distributed over the earth.

In the typical, complete flower, four sets of organs are present: the calyx, the corolla, the stamens, and the pistil. The calyx is the outer whorl of leaves, usually greenish in color, which, before the flower opens, functions in much the same manner as the bud scales, preventing the delicate inner parts from suffering injury due to water loss. The calyx is composed of several separate leaves known as sepals. The corolla is the showy colored part of most flowers, and is made up of a number of colored leaves, petals, which may be entirely separated from each other, or in some cases are more or less united at the base. The stamens, several in number, are usually separate, filamentous structures which bear an enlarged body at the upper end known as an anther or pollen case. Their function is to produce the pollen. The pistil consists of three parts: the ovary or basal enlarged portion which is usually somewhat inflated and bears the ovules or young seeds; the style, a filament about the size of the stamens and growing up to about the same level with their tops, or sometimes projecting beyond them, and the stigma, or the swollen expanded end of the style.

The stamens and the pistil are the essential parts of the flower, while the calyx and corolla are known as the accessory parts.

When the flowers are fully developed the anther case breaks open and the pollen is shed from it. In order for a seed to be formed, some of this pollen must fall upon the stigma and develop into a long burrowing tube which grows down through the style into the ovule or young seed. This is known as the pollen tube, and each ovule must receive such a tube or die. The pollen tube is microscopic in size and bears the male reproductive, or sperm cells. Inside the young seed or ovule, the female reproductive cell, the egg cell, is borne. The pollen tube penetrates the opening to the ovule and delivers the male cell to the female. These two cells then fuse completely into one. This process is known as fertilization, and the embryo plant develops from the fertilized egg cell. The embryo plant with the tissue surrounding it is called the seed.

Of all the processes carried on by plants, the method by which a seed is formed is perhaps the most striking and interest-

ing. It is the device by which perpetuation is insured. The chief problem of each organism that lives is to maintain its existence during life and to leave others like itself when it dies. The flower then is the structure upon which the perpetuation of the species depends and toward which all the energy of the tree is directed. The mightiest trees which today inhabit the earth began life, some of them, perhaps eight thousand years or more ago, when the pollen tube delivered its sperm cell to the egg cell in the young ovule. For in this way, and this way only, can a new individual originate.

The transfer of pollen from the anther to the stigma is known as pollination. When the pollen is borne on one flower and the stigma on another, the process is known as cross-pollination; but if they are produced in the same flower it is called self or close pollination. Perhaps the great majority of plants favor cross-pollination, for there are many evidences in support of this theory. In many plants the flowers are incomplete; that is, some flowers bear only stamens while others bear only pistils, and in some plants these two types are borne on separate individuals. Such plants are called dioecious.

Cross-pollination is brought about through the agency of the wind, water and insects. Wind pollenized flowers are usually small, consisting only of the essential flower parts, while those which are visited by insects are usually larger, more showy and produce nectar and odor. The relationship which exists between insects and flowers is one of the most interesting chapters in biology. The insect and the flower have evolved together, and they perform for each other a mutual service. The insect visits the flower in order to procure food, but while there its body becomes dusted with pollen, and this is transferred to other flowers which it then visits. The pollen of one species will grow only upon the stigma of the same or of a closely related species. This tends to keep each species pure. However, crossing may occur provided the pollen of one species is carried to the stigma of another that is closely related to it. This has led to the improvement of many of our cultivated varieties of plants as well as to the origin of entirely new hybrid varieties.

Flowers are either borne singly on the stem or in clusters. When the flowers are solitary, they are either on short lateral

shoots in the axils of leaves, or at the end of the main axis of the shoot. Flowers which occur in clusters may be grouped for convenience into a number of definite types. A *raceme* of flowers or fruits is an arrangement of the individual flowers on the more or less elongated axis, each with a separate pedicel, all about equal in length. A *panicle* is a flower cluster in which the simple pedicels of the raceme become branched and spreading. A *corymb* is also like the raceme, but in this case the flower shoot is shortened, and the lower pedicels are longer than those borne above them, so that the clusters become flat topped with all the flowers borne at about the same level. A *cyme* resembles a corymb, but in this case the pedicels become branched and the central flower blooms first. An *umbel* is a flower cluster in which the pedicels of the flowers start from the same point and become about of equal length. A *head* is a cluster in which the axis is very short and the flowers are without pedicels, or nearly so, forming a globose or compressed cluster. A *catkin*, or ament, is a long, slender, drooping axis which bears numerous solitary sessile flowers in the axils of bracts, the whole cluster falling away after the maturity of the flowers. Among trees, the willows, poplars, oaks, and birches bear their flowers in catkins.

A flower has been defined as the forerunner of a seed; but plants bear their seeds in some kind of a structure known as a fruit, consisting of the ripened ovary, and sometimes other accessory parts. The fruit is a structure which aids in the distribution of seeds. Fruits are either dry or fleshy. Dry fruits may be grouped under two heads: those which open and shed their seeds at maturity are dehiscent, those which do not open are indehiscent. Of the indehiscent fruits, our commonest examples among the trees are the samara or the dry winged fruits of maples, elms, ash, ailanthus, hop tree, etc.; the acorn of the oaks; the nut of the walnut and hickory. The dry dehiscent fruits are known as pods if the seeds are fastened along one side and there is but a single cavity, otherwise they are called capsules.

Among the fleshy fruits our commonest examples are the berry, pome, and drupe. The term berry may be used to denote all fleshy fruits with more than one seed buried in the mass of pulp. The pome or apple fruit differs from the berry by bearing the seeds inclosed by a hardened substance. The drupe is a single-seeded fleshy fruit.

DISTRIBUTION OF TREES IN TEXAS

Within the wide domain included by the boundaries of Texas, the natural conditions which go to determine the distribution of trees are extremely varied in character. The chief factors which have influenced distribution are rainfall, character of the soil, temperature, light and winds. Of these the first two are by far the most important.

The factor which more than any other dominates the distribution is rainfall. This is shown by the transition which takes place in the character of the tree flora from the moisture-loving species of the eastern part of the state to the drought-resistant varieties of the west.

A map of Texas constructed to show the difference in annual rainfall for each degree of longitude divides the state into nine zones differing from each other by five inches of rainfall and extending in a general north and south direction across the state. The first of these zones receives an annual rainfall of more than fifty inches, and in this zone the trees reach their maximum size and abundance. The second, with forty-five inches, extends to the ninety-sixth meridian, the third, with forty inches, extends to the ninety-seventh, and so on to the one hundred and second, where the rainfall is fifteen inches. These zones, passing from north to south across the state, include a wide variety of soil types and physiographic features, which have, to a certain extent, modified the character of the vegetation. In order to understand fully the factors which have influenced the distribution of trees in any area, it is necessary to consider the quality of the soil, the physiographic features and all the climatological factors.

The trees which inhabit the eastern part of the state are extensions of the forests of the Atlantic and gulf coastal plains, as well as some from the Middle and North Atlantic States. These trees are all adapted to abundant rainfall and become checked near the Brazos River by the dry climate of the Southwest. Concerning the further westward extension of this forest area, Bray says: "Here its vanguard is broken into straggling detachments of which only the hardier varieties push onward along the prairie streamways or up the deeper canyons of the hills. It is a striking phenomenon this breaking and gradual dwindling away of so vast and vigorous a forest. Not only in

Texas, but far to the north, through Indian Territory, Kansas, Nebraska and the Dakotas, the same thing may be seen. Like a vast wave that has rolled in upon a level beach, the Atlantic forest breaks upon the dry plains—halting, creeping forward, thinning out, and finally disappearing, except where along a river course it pushes far inland.”—Forest Resources of Texas.

The trees of central Texas are made up of these last straggling remnants of the mighty forests of the eastern states; some species which have reached into it from Mexico and the Rocky Mountains, together with others which are not found in any other part of the world and may be regarded as its own peculiar product. Central Texas is, therefore, the meeting ground for the outposts of three great forest areas, and is peculiarly rich in the variety of its tree flora.

The trees of the Southwest and West are principally species which have a wider distribution into Mexico and the Rocky Mountains.

INFLUENCE OF FORESTS ON CLIMATE, RUN-OFF AND EROSION

The chief value of forests is as a source of timber, but in many parts of the world they exert other influences which are of the utmost importance. The chief subsidiary value of the forest is in its relation to the climate, run-off, and erosion.

The influence of forests on climate is chiefly to render the atmosphere more humid, to modify the radiation of heat, and check the winds. It is a popular belief that forests exert an influence on the amount of rainfall over a given area, but this theory has not been substantiated by any experimental data. It is very doubtful if forests influence in any way the actual amount of precipitation. They do, however, exert a profound influence on the retention of water, thus controlling run-off and erosion.

In the forest the heavy rain, as it falls, is checked by the branches and leaves of the larger trees, particularly when they are in full leaf. From these the water drips to the smaller trees and undergrowth and then to the carpet of leaves below. Here it is held in great quantities and slowly percolates into the humus soil, which is also able to hold many times its own weight of

water. In this way long continued heavy rains are required before the excess water begins to flow off into streams and rivers. The water which percolates down into the soil gradually runs away to feed streams and springs, and thus maintains their steady flow throughout the year. It is a very noticeable fact that springs are much more common in forested lands than in the open, and that they usually cease to flow when the forest is removed. The water-holding power of a watershed is much greater if it is covered with timber than with any other vegetation, but grassy plains catch and hold much more water than cultivated areas. The removal of forests, and the cultivation of the areas once occupied by them, has given rise to the various floods which now occur on many rivers throughout the country. Concerning erosion, it has been estimated that 1,000,000,000 tons of sediment are annually pouring into the seas from the rivers of the United States. This material is derived from the surface layers, the richest part of the soil, and its land value, the annual loss, would exceed all the land taxes of the country. The soil actually removed does not, however, constitute the entire danger. The surface of the hillside areas frequently become so gullied that they can no longer be tilled, and all productive power is lost.

SHADE TREES

Aside from their more readily estimated value for fruit, timber, and fuel, trees are valuable for shade and ornament. The ornamental shade tree ministers not only to our physical comfort, but also to the aesthetic pleasures which come to us through a perception of beauty. The chief value of trees for city streets, lawns, and parks is due to the beauty which can be developed by their use. It is a value not always appreciated by all, and one which should be enhanced by education.

There is a growing sentiment throughout the country in favor of the planting and care of shade trees. In the past, each owner has planted along his property such trees as he saw fit, and given them such attention as his knowledge and circumstances permitted. This has resulted in miscellaneous collections of trees, devoid of design, harmony and adaptation of means to an end—the very principles upon which beauty depends.

In many of the cities of this country the work of planting and

care of trees for streets and parks has been placed under the supervision of an experienced official, who superintends the work for the entire city. This method is bringing about much better results, and is to be recommended wherever practicable. Every city should take some action to encourage more uniformity in the matter of planting trees. Trees for any given street should be of the same variety, equally spaced, planted the same distance from the sidewalk, pruned to the same height and kept in a healthy condition. They should be free from the ravages of horses' teeth, the old-time "tree pruner," the merchant's sign poster, and the telephone lineman—the worst pests of street trees.

A city with beautiful avenues, lined on either side with such trees, possesses an asset of almost inestimable value, for it contributes to the happiness and civic pride of all its people and hence elevates the tide of life through an appreciation of the beautiful.

Trees for parks should represent all the varieties possible in as nearly as practicable their natural forest habits. A native wooded park is an asset which no city or town can afford to consider lightly. One of the most delightful spots in all Texas is to be found in beautiful Brackenridge Park of San Antonio. This fine tract of native woodland, generously donated to that city by Mr. George W. Brackenridge, will become a priceless heritage as the years go by. If the wishes of the former philanthropic owner and lover of nature are observed, it will never be defiled by ax or saw, but will remain forever to inspire in the hearts of men a love and reverence for the passing things of wild free nature; as they come down to us undefiled by the hand of man. What better gift could be bestowed by any philanthropist than this, and what better precedent might be followed by others.

THE NAMES OF PLANTS

Plants, like everything else, are given names by which they may be designated. We recognize plants both by common and scientific names. The common name of a plant is the name by which it is known locally, and frequently differs in various sections of the country. The so-called Texas long leaf pine of East Texas becomes the Georgia pine further east. In fact, this one pine is known by as many as thirty different common names in

different parts of its range. The scientific name of a plant is given to it by the individual who first describes the species, and the name of the species is usually followed by the name of the man who described it. For example, *Quercus alba* L. means that this plant was originally described by Linnaeus and given the name *Quercus alba*. No other plant is known by this name. Scientific names should be used more extensively by all in designating plants, for it is only through this means that we are able to know with certainty that reference is made to a definite species. The name of a plant consists, usually, of two parts or words, as, for example, *Prosopis glandulosa*, *Pinus palustris*, *Ulmus Americana*, *Quercus nigra*. The first of these words indicates the *genus* to which the plant belongs, and is always capitalized, the second indicates the *species* and is only rarely capitalized.

The classification of plants is an attempt to express their actual kinship, or what we are accustomed to know as blood relationship. Each kind of plant is known as a species. A species consists of a group of individuals which resemble each other more than they resemble any other individual. For example, all of the trees which we call *Ulmus Americana* are more like each other than they are like any other group of trees. Then there are groups of species which are more like each other than they are like any other species. Such a group is known as a genus. There are in our area four species, all of which are more like *Ulmus Americana* than they are like any other species, but each differs from it and from each other in certain essential characteristics. These species are *Ulmus Americana*, *Ulmus alata*, *Ulmus crassifolia* and *Ulmus fulva*. The name of the species consists of the generic name which denotes the genus, and is followed by the specific name which defines the species. But the genus and species is not the complete expression of the relationship of any given plant. There are groups of genera which resemble each other more closely than they resemble any other genera. Such groups are known as families; for example *Ulmus* (elms) and *Celtis* (hackberry) make up the family *Ulmaceae*. Families are likewise grouped into orders, and these in turn into larger groups.

It should be borne in mind that, knowing the name by which a plant is designated marks only the beginning of an acquaint-

anceship with it. It serves merely as our introduction. An intimate acquaintance depends on a knowledge of its distribution, family relationship, characteristics, soil and water requirements, products, economic or horticultural value—in short, all that may be learned about it. The writer hopes that no one will be found who retains the hopeless attitude that to know more about plants causes a lessening of our appreciation of their beauty.

HOW TO USE THE KEY

The number of species which occurs in our tree flora is so great that descriptions alone would not enable the beginner to determine the name of a tree without long and tedious effort, which in the end would frequently prove uncertain. Accordingly, the key has been arranged in such a way that if followed step at a time the investigator may arrive at the proper description with relative ease and accuracy. Suppose, for example,

I. Outlines and Bases of Simple Leaves.

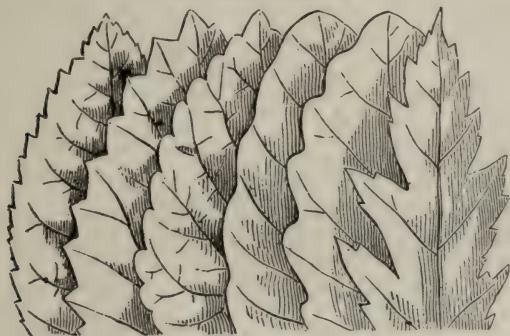


1. Linear. 2. Lanceolate (lance-shaped). 3. Oblong. 4. Elliptic.
5. Oval. 6. Ovate (egg-shaped). 7. Oblanceolate. 8. Spatulate
(spatula-like). 9. Obovate (reversed ovate). 10. Cuneate (wedge-shaped).

one wished to find the name of the American elm. The first choice to be made is between "leaves needle, scale or awl-like; fruit a cone of dry scales or a berry-like cone," and "leaves with expanded blades, fruit not as above." This choice is easily made in favor of the latter. Under "I," leaves compound, or "II," leaves simple, the beginner will find it necessary to consult the glossary and illustrations to determine just what is meant by

these terms, when his decision will be in favor of "II." Then he must determine whether the leaves are opposite or alternate on the stem. Here his decision goes to "B," leaves alternate. Under "B," the choice goes to "2," leaves with "netted veins," then to "b," "leaves with only one primary vein at base." The next choice is between "leaves entire and blade of leaf serrate or notched," "(1)" or "(2)." In this case the second is found correct. After this the choice falls on "(a)," "veins of leaves straight," not prominently branched then "y." Trees not thorny

II. Leaf Edges.



1. Serrate (saw-toothed). 2. Dentate (toothed). 3. Crenate (scalloped).
4. Undulate (wavy). 5. Sinuate (bayed). 6. Incised (jagged).

and finally "(x)" leaves oblique at base, and "m" fruit a circular samara, leaves harsh to the touch. This leads unerringly to the genus *Ulmus*, and no other tree in our flora can be placed here if the observations are carefully made and each decision accurately drawn. Turning to the page reference a descrip-

III. Leaf Tips.



1. Acuminate. 2. Acute. 3. Obtuse. 4. Truncate. 5. Retuse. 6. Emarginate.
7. Obcordate. 8. Cuspidate. 9. Mucronate.

tion of the genus is given. Here again the student should check each statement in the description, to see if it tallies with the specimen at hand. If correct, the key to the genus must next be consulted. Here the choice goes to "flowers opening in the spring before the leaves." "Branches not corky winged." "Leaves smooth or somewhat roughened above, inner bark not mucilaginous"

ous." The determination is then checked by turning to the description of the species and consulting the illustration. If the pine is taken, the first choice goes to "leaves needle scale or awl-

IV. Lobed Simple Leaves.



Pinnately: 1. Lobed. 3. Cleft. 5. Parted. 7. Divided.
 Palmately: 2. Lobed. 4. Cleft. 6. Parted. 8. Divided.

shaped," etc., which leads to the family Pinaceae. Here the decision is between "leaves all needle-shaped" and "leaves scale-like and appressed to the stem, or some of them awl-shaped, spreading." If the leaves are needle-shaped and borne in clusters of two to five, the species goes to the genus *Pinus*.

It is believed that practice in the use of the key will soon enable one to locate the family, genus, and species with almost certain accuracy. It must be borne in mind that accuracy of observation is necessary to its successful use.

V. Compound Leaves.



1. Odd-pinnate. 2. Tendril-pinnate. 3. Even-pinnate.



4. Palmate or digitate.



5. Twice-pinnate.

A KEY TO THE TREES OF TEXAS

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 - x. Veins of leaves prominently curved, fruit a red drupe.Cynoxolum 145
 - y. Veins not prominently curved, fruit a black drupe..Chionanthus 154
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 - x. Fruit an elongated persistent pod, leaves linear sometimes alternate.....Chilopis 156
 - y. Fruit a globose structure of nut-like bodies.....Cephalanthus ..157
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PINACEAE. The Pine Family.

Trees with a resinous juice; leaves linear or scale-like, clustered, or borne alternately on branches, mostly evergreen; fruit a dry cone, or sometimes a berry. A family with about 250 species distributed throughout the world, but confined principally to temperate regions. They are of great economic importance as a source of resin, tar, turpentine and pitch as well as for lumber and ornamental planting.

Leaves all needle-shaped.

Leaves borne in clusters of two to five..... 1 *Pinus*.

Leaves scattered on the stem.

Leaves deciduous..... 2 *Taxodium*.

Leaves evergreen..... 3 *Pseudotsuga*.

Leaves scale-like and appressed to the stem, or some of them awl-shaped, spreading.

Fruit a small cone consisting of a few scales:

Cones ovoid to oblong..... 4 *Thuja*.

Cones globose..... 5 *Chamecyparis*.

Fruit fleshy, berry-like.

Leaves awl-shaped, spreading on mature branches, cones axillary..... 6 *Juniperus*.

Leaves scale-like, appressed on mature branches, cones terminal..... 7 *Sabinia*.

1. PINUS. The Pines.

Monoecious, evergreen trees or rarely shrubs of great economic importance. The leaves are borne in clusters of two to five upon minute dwarf branches. The main stem produces branches regularly in whorls which decrease in length towards its apex, thus giving the tree a conical appearance. Flowers borne in the spring; the fruit, a woody cone, not ripening until the season following. The seeds are borne in pairs at the base of the cone scales.

Leaves in 5's with a deciduous sheath at base,

cone scales unarmed..... 1. *P. flexilis*.

Leaves in bundles of three.

Cones subterminal, cylindrical or conical—oblong, slightly curved, armed with small reflexed prickles..... 2. *P. palustris*.

Cones lateral, ovate-oblong, armed with short, stout prickles..... 3. *P. taeda*.

Leaves in bundles of two or three.

Cones oval to oblong-oval; scales without prickles; leaves short, $\frac{3}{4}$ ' to $\frac{1}{4}$ ' long.... 4. *P. edulis*.

Cones subterminal, 5'-15' long; scales armed with stout prickles..... 5. *P. ponderosa*.

Cones lateral, conic, $1\frac{1}{2}$ '- $2\frac{1}{2}$ ' long..... 6. *P. echinata*.

Leaves in bundles of two; cones ovoid to globose; spines short or none..... 7. *P. glabra*.

1. *Pinus Flexilis* James. Rocky Mountain White Pine. Bull Pine. Limber Pine.

A round topped tree reaching a maximum height of 40° - 50° and trunk diameter of 2° - 5° with short trunk, stout branches, and thick fissured bark. Leaves borne in clusters of five, about $1\frac{1}{2}$ '-3' long, stout and stiff. Cones 3' to 10' long. Wood soft, close grained.

Alberta southward to southeastern California and western Texas, extending into the Guadalupe and Limpia mountains.

The wood belongs with the yellow pines. It is soft and easily worked, but the trees of our area are too small to be of much value for timber.

2. *Pinus Palustris* Mill. Long Leaf Pine. Texas Long Leaf Pine. Texas Yellow Pine.

A large forest tree with a maximum height of 100° - 120° and trunk diameter of 2° - 3° with narrow crown and thin, scaly, orange brown bark. Leaves bright green, soft, and flexible, sharp tipped, 8' to 18' long, borne in clusters of three with a sheath at base. The cones are almost sessile, cylindric, or oblong, 6'-10' long, frequently slightly curved. The scales are thin, flat and armed with a small reflexed spine.

Southeastern Virginia to Florida and along the Gulf coast through Louisiana to Texas. It grows in sandy soil and is not common in river valleys. In Texas it extends to the Trinity River.

The wood of this pine is stiff and hard, possessing great strength. It is much used in the central and eastern part of the United States as bridge wood. It is also well adapted for frames, and trusses for large buildings. Large quantities of this wood are employed for flooring and car building. In addition to the wood, it yields valuable naval stores, such as rosin, pitch, turpentine, and oils. The forests of the older



Fig. 1. Long leaf pine forest in East Texas. (Bray Bulletin 47 U. S
Dept. of Agr.; Bureau of Forestry.

Gulf States have been largely depleted of this fine wood and the supply in Texas will be exhausted in a few more years.

3. ***Pinus taeda* L.** Loblolly Pine. Old-field Pine.

A large, round topped, forest tree with straight, tapering



Fig. 2. *Pinus taeda*.

trunk, reaching a height of 80°-100° and a maximum diameter of 5°, with stout branches and reddish brown ridged bark. Leaves pale green, slender, stiff, 6' to 9' long, borne in clusters of three with a sheath at base. Cones conic

cylindric, 3' to 5' long. The scales are armed with a straight or somewhat curved stout spine.

Southern New Jersey to Florida, Louisiana, and Texas and in the Mississippi Valley to Arkansas and Oklahoma. In Texas, it extends to the valley of the Colorado.

The loblolly pine is perhaps the most aggressive of all the pines of our area. It is known in many localities as "old-field pine," because of its ability to take possession of, and reforest old fields where corn and tobacco once grew. It will in all probability be with us long after the longleaf has disappeared.

The wood is not of as good quality as the longleaf pine, being rather weak, coarse grained and brittle. It is employed in the manufacture of doors and different kinds of finish.

4. *Pinus edulis* Eng. Rocky Mountain Nut Pine. Pinion Nut Pine. Pinion Pine.

A small tree which may reach a height of 30°-40° and diameter of 2½°, but is usually much smaller. The trunk is frequently divided almost to the ground. Leaves dark green, stout, ¾'-1½' long, sharp pointed and borne in clusters of two or three without a sheath. Cones nearly globose, the scales unarmed. The seed is ½' long, nearly cylindric and contains a sweet, resinous endosperm.

Southwestern Wyoming, Colorado, Utah, western Texas to Arizona. In Texas, it is confined to the mountains of the western portion of the state.

The trees of our area are too small to be of much use for timber. The chief product of value is the nut, which is of some commercial importance.

5. *Pinus ponderosa* Dougl. Bull Pine. Yellow Pine. Rocky Mountain Yellow Pine.

A tree reaching a maximum height of 100°-200° and trunk diameter of 4°-6°, usually about two-thirds the above dimensions, with very thick, reddish-brown, deeply furrowed bark. Leaves in 3's, five to ten inches long. Cones reddish-brown, oval when open, narrowly ovate when closed; scales armed with a stout recurved prickle; seeds dark brown ovate, flattened at the apex 3 to 4 lines long, winged, the wing ¾ to 1 inch long, widest above the middle.

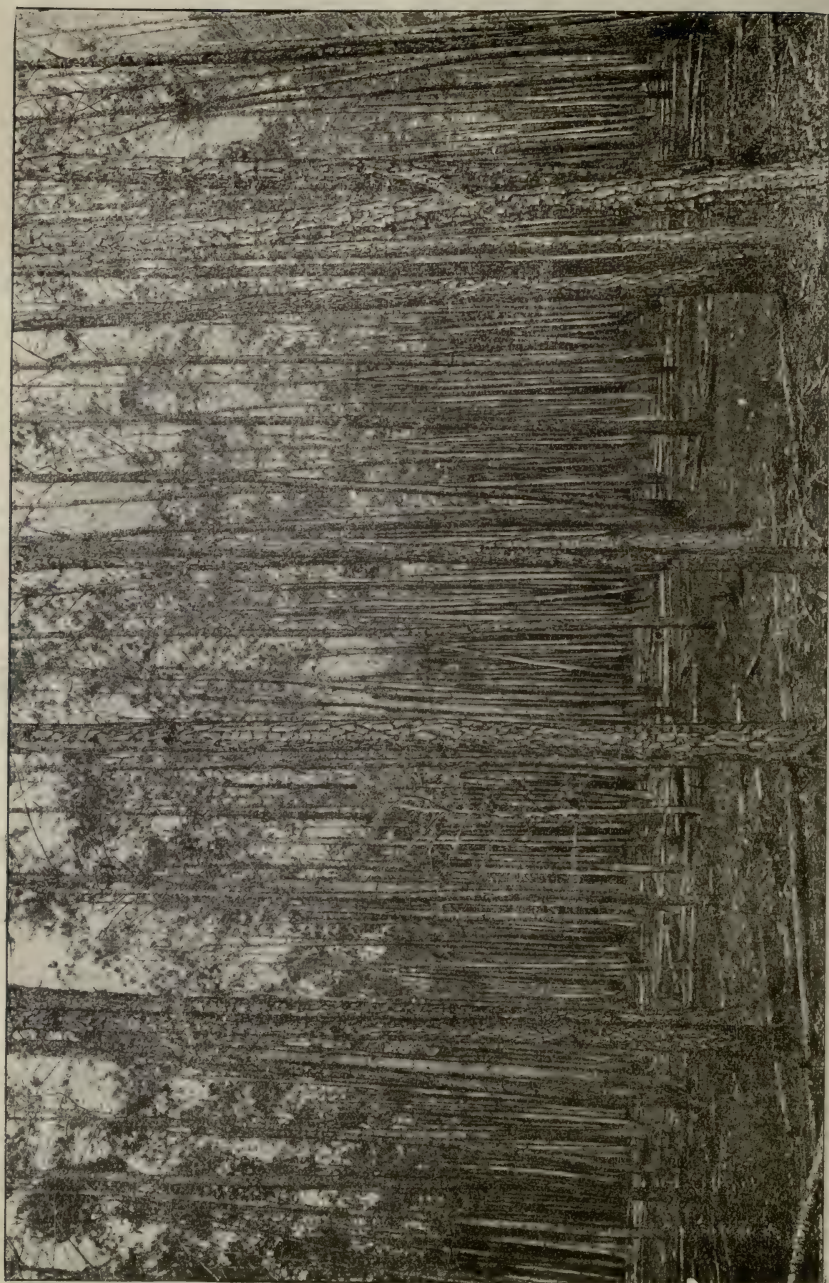


Fig. 3. Loblolly pine forest in East Texas (Bray, Distribution and Adaptation of the Vegetation of Texas).

A western mountain form extending from Montana and British Columbia to California and Mexico, eastward to Nebraska and Western Texas. In Texas, it reaches the Guadalupe and Limpia Mountains, and extends northward.

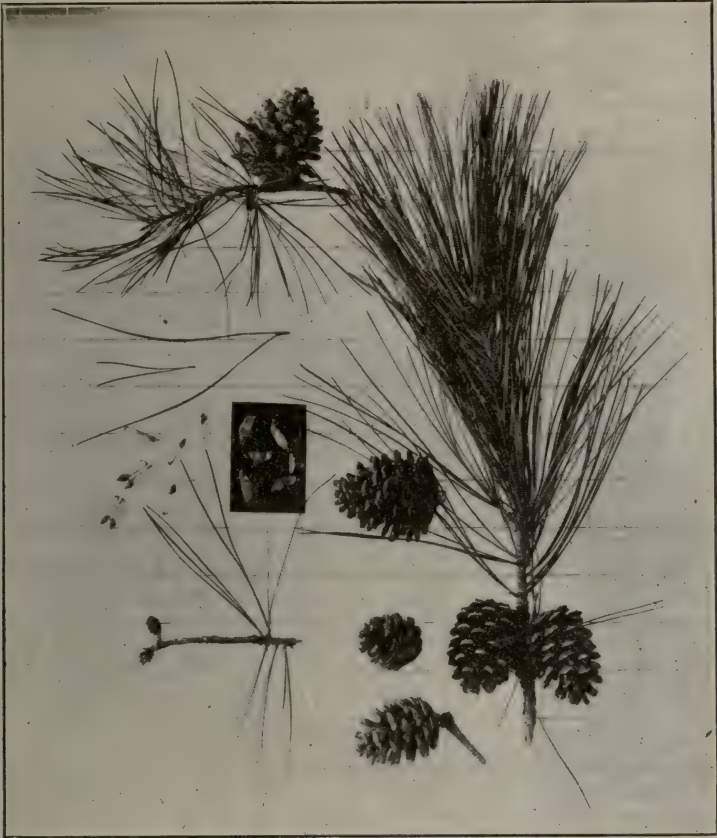


Fig. 4. *Pinus echinata*.

Pinus ponderosa grows in a wide variety of habitats. It is at home on the moist fertile mountain slopes and plateaus, dry or rocky ridges, fertile gravelly valleys, and arid desert slopes. It reaches its maximum size and abundance in the yellow pine belt of the Sierra Nevada.

The trees of our area are small and of comparatively little value. The wood is classed with the yellow pines. It is soft

and easily worked and does not contain so much rosin as the longleaf pine.

6. ***Pinus echinata*** Mil. Short-leaved Pine.

A forest tree reaching a height of 80°-100° and a maximum trunk diameter of 3° to 4° with rough, coarsely furrowed bark. Leaves deep green, borne in clusters of two or three, 3'-5' long, shorter than any other timber pine of Texas, slender, soft and flexible. Cones 1½'-2½' long, conic when closed and ovoid when open; the cone scales armed with slender spines; seeds ¼' long, winged.

New York to Kansas, Florida and Texas. In Texas it is found in the northeastern portion of the state.

The short-leaf pine is the most extensively used wood in Texas. The wood is soft and works easily. It is used principally in the manufacture of doors, sash, and for interior house finishing wood.

2. **TAXODIUM** Rich. The Bald Cypress.

Taxodium distichum (Linnaeus) L. C. Richard. A large forest tree with maximum height of about 150° and 4°-5° in diameter, with a straight buttressed base which is frequently hollow. Trees growing in wet localities frequently develop projections from the roots known as "knees," which project above the water; bark smooth and rather brownish red, branches short, slender, horizontal or drooping, disappearing below from the old trees, forming an irregular crown. Leaves thin, flat, 2-ranked, linear, ½'-¾' long, somewhat curved, sharp pointed, sessile; shed with the lateral twigs in the fall. Cones globose 1' in diameter, borne in pairs at the ends of the branches.

It extends from Delaware to Florida westward along the Gulf Coast to Texas, and up the valley of the Mississippi to Missouri and southern Indiana. In swamps it is frequently the predominating tree, often forming extensive forests. In Texas it occurs sparingly in the valley of the Nueces confined mostly to overflow land along river bottoms and in canyons. The tree is a very slow growing one, and requires two or three centuries to produce a trunk large enough for saw logs.

There are few young trees coming on, and with the drainage of swamps and the building of levees along the river this tree will gradually give way to more rapidly maturing species. It has been strongly recommended by some nurserymen for



Fig. 5. Bald cypress forest about the Neches River. (Bray Bulletin 47 Bureau of Forestry, U. S. Dept. Agr.).

ornamental planting. It is successful only in wet soil, where it doubtless has some horticultural value.

The wood is light, soft-grained, but not strong. It is easily worked, and does not shrink or warp much. Its chief use is for construction purposes.

3. *PSEUDOTSUGA* Sudw.

Pseudotsuga mucronata Sudw. Douglas Spruce. Red Fir. A very large forest tree sometimes 200° high and 3°-4° in diameter, but usually smaller, 80°-100° high with narrow crown and thick, deeply furrowed bark. Leaves straight or slightly curved, $\frac{3}{4}$ '-1 $\frac{1}{4}$ ' long, dark yellowish green to bluish

green. Male cones orange red; female characterized by the elongated red bracts. The mature cones are 2'-4½' long, borne on stout stems.

British Columbia, south to Colorado, Arizona, Texas and Mexico. In Texas it is found only in the northwestern part of the state.

The heart wood is light red or yellow with almost white sapwood and is used extensively for lumber.

4. **THUYA** (Tournefort) L. Arbor Vitae.

Aromatic slightly resinous, evergreen trees or shrubs with opposite, scale-like, imbricated, four ranked leaves. Staminate and pistillate flowers borne on the same tree but upon different branchlets. Mature cones, elongated, consisting of 8-12 scales. A wide range of ornamental varieties occurs in our area.

5. **CHAMAECYPARIS** Spach. Chinese Arbor Vitae.

Resembling Thuya and distinguished from it by the globose shaped cones. Extensively cultivated for ornament.

6. **JUNIPERUS**.

Juniperus communis L. Juniper. A small erect conic shap tree with slender branches and thin reddish bark which splits into persistent scales. The leaves are awl-shaped ¼'-½' long, spreading, borne in whorls of three and persisting for many years. Fruit a subglobose berry-like cone ⅓' in diameter, blue or almost black with a bloom, borne in the axils of leaves. Seeds usually solitary.

It ranges from Greenland and Labrador to Alaska, south to Pennsylvania, Nebraska, New Mexico and Texas. It occurs only rarely in the dry sterile hills of northwestern Texas.

The wood is hard, close grained, dark brown in color. It is durable and takes a fine polish. It is used for finishing, chests and furniture. The tree is planted extensively in its natural range for ornamental purposes.

7. **SABINA.** Haller. The Cedars.

Monococious or dioecious, strong scented trees or shrubs. Leaves scale-like or sometimes awl-shaped, appressed to the stem, not spreading on mature branches, each with a gland on the back. Flowers and fruit terminal. Cone berry-like.

Fruit reddish brown, large with 1-12 seeds.

Seeds usually 4	1 <i>S. pachyphlaea</i> .
Seeds 4-12	2 <i>S. flaccida</i> .
Seeds 1-2	3 <i>S. Pinchoti</i> .

Fruit blue or blue-black, small.

Leaves denticulate.

Fruit globose or oblong, seeds usually 1, rarely 2, branchlets slender..... 5 *S. monosperma*.

Fruit globose, seeds 1-4, leaves keeled and glandular 6 *S. sabinoides*.

Leaves entire.

Fruit subglobose $\frac{1}{4}$ ' to $\frac{1}{3}$ ' long, seeds 1-4, branchlets stout, not pendulous or only slightly so, often erect..... 7 *S. Virginiana*.

Fruit subglobose $\frac{1}{8}$ ' in diameter, seeds usually 2, branches pendulous..... 8 *S. barbadensis*.

Fruit subglobose ripening the second season, $\frac{1}{9}$ '- $\frac{1}{3}$ ' in diameter; seeds usually 2, branchlets rigid, often erect..... 9 *S. scopulorum*.

1. **Sabinia pachyphlaea** Torr. Juniper. Thick-barked Juniper. Mountain Cedar.

A tree reaching a maximum height of 50 to 60 feet and diameter of 3-5 feet, with long branches and thick, scaly, red-brown bark divided into 4 sided plates. Leaves in pairs about $\frac{1}{8}$ inch long, appressed, keeled and glandular, bluish green. Fruit globose about $\frac{1}{2}$ inch long, reddish brown, and contains a sweet mealy flesh.

At altitudes of 4000 to 6000 feet from Colorado to Nevada, Utah, Arizona, New Mexico, and Texas. In Texas it is found only in the western part of the state.

The wood is soft and brittle and is not used extensively. The fruit is used for food by the Indians.

2. **Sabinia flaccida** Schlecht. Drooping Juniper. A tree reaching a height of 30° or often only a shrub. The branches are wide spreading, and the long drooping branchlets give the tree a characteristic appearance. Leaves about $\frac{1}{8}$ ' long,

opposite, light yellow green, and conspicuously glandular on the back, and slightly toothed on the margin. Fruit globose to oblong, $\frac{1}{2}'$ to $\frac{3}{4}'$ long, dull reddish brown with a glaucous bloom. Seeds 4-12, some of them abortive.

Extending from eastern Mexico to the Chisos Mountains of southwestern Texas. It grows best at altitudes of 6000-8000°.

3. *Sabinia Pinchoti* Sudworth. Pinchot's Juniper. A small tree 20 feet in height, with very short trunk. Leaves usually in threes, but sometimes in twos; margin entire, sharp pointed, keeled, and glandular, about $\frac{1}{12}$ inch long. Fruit globose about $\frac{1}{3}'$ long, red or copper colored without bloom; seeds 1 or 2.

Found only in Briscoe, Randall, and Armstrong counties, Texas. It grows associated with *S. monosperma*. It has the peculiar habit of throwing up numerous sprouts from fire killed stumps. Frequently several of these shoots develop into main trunks.

The wood is close grained, but rather soft. It is used for fence posts, and for fuel.

4. *Sabinia monosperma* (Engelman) Sargent. One-seeded Juniper. A tree reaching a maximum height of 40 to 50° and trunk diameter of 2° with stout branches, ascending and slender twigs. Leaves in twos or threes, about $\frac{1}{8}'$ long, sharp pointed, and sparingly glandular; fruit dark blue glaucous with sweet resinous flesh; seeds usually solitary but sometimes 2 or 3.

Eastern slopes of the Rockies extending from Colorado to Utah, Nevada, New Mexico, Arizona, and Texas.

The wood is hard, close grained, and is very durable. It is used largely for fence posts, and for fuel. The fruit is used as food by the Indians. The fibrous inner bark is also utilized somewhat as fiber.

5. *Sabinia sabinoides* (H. B. K.) Small. Mountain Cedar. A shrub or small tree reaching a height of 40° and diameter of 1° with short trunk and shreddy brown bark. Leaves scale-like, appressed and imbricated, opposite, minutely toothed on the margin, $\frac{1}{4}'$ - $\frac{1}{2}'$ long, long pointed, sparingly

glandular. Fruit almost globular $\frac{1}{4}$ '- $\frac{1}{2}$ ' in diameter, dark blue with thin, sweet resinous flesh. Seed 1-4 ribbed.

In the limestone hills of central and western Texas extending to Mexico.

The wood is hard, close grained but weak. It is used very



Fig. 6. *Sabinia sabinoides*.

extensively for fence posts, telegraph poles and for fuel. The tree is also used somewhat for ornamental planting in the region in which it is native.

6. ***Sabinia virginiana*** (L.) Antoine. Red Cedar. A rather

large tree reaching a height of 90-100° and trunk diameter of 4-5°, but usually much smaller, sometimes shrub-like, with ragged and sheddy bark. Leaves mostly scale-like, appressed, opposite and four-ranked, $\frac{1}{4}'$ long, glandular. The leaves on young twigs are frequently linear-lanceolate, $\frac{1}{2}$ inch long, sharp pointed, somewhat spreading.

Fruit globular or nearly so, $1\frac{1}{5}'$ - $1\frac{1}{3}'$ in diameter, blue, covered with a bloom, ripening the first autumn. The seeds are flattened $\frac{1}{4}'$ long, smooth.

Nova Scotia, New Brunswick, western Ontario, South Dakota and extending southward to Florida, Alabama, and eastern Texas.

The wood is close grained, soft and weak. It has a beautiful red heart wood, which is used for furniture making, chests and pencils. It is also used extensively for posts, as it is quite durable. Oil of juniper is distilled from the leaves and wood. The tree is extensively cultivated for ornamental purposes.

7. *Sabina scopulorum* Sargent. Rocky Mountain Red Cedar. A tree 30°-40° in height with a trunk sometimes reaching a diameter of 3° but more often divided near the ground into a number of secondary stems. Leaves opposite, borne in pairs, closely appressed to the stem, glandular, dark green or frequently pale and glaucous, entire on the margin. The fruit is nearly globose $\frac{1}{4}'$ to $\frac{1}{3}'$ in diameter, bright blue with a bloom, ripening the second season. Seeds one or mostly 2, prominently grooved and angled.

From Rocky Mountain foothills, extending to western Texas, and west to Arizona, Nevada, Oregon, and Washington.

ARECACEAE Reichenb. The Palm Family.

Trees with upright stems, which bear a crown of leaves at the end. The leaves in our species are large, fan-shaped, palmately cleft or divided. Fruit a dupe or a berry.

1. *Sabal* Adams. The Palmetto. Unarmed trees with stout upright trunks, which are covered with a red-brown rind. The tree is characterized by the fiber-like threads which droop from the margins of the leaf segments.

Bracts of the flower cluster 7° to 8° in length.

Fruit globose, one-celled..... 1 S. Palmetto.

Bracts of the flower cluster 2° to 2-½° in length,

fruit often 2-3 lobed with 2 or 3 seeds..... 2 S. Mexicana.

1. **Sabal Palmetto** R. & S. Cabbage Tree. Cabbage Palmetto. A tree with maximum height of 30° to 40° and diameter of 2°; leaves 5° to 6° long and 7° to 8° broad, dark green, divided into numerous narrow segments. The leaf petiole is 6°-7° in length. Flowers in axils of deciduous bracts, full globose.

Found in dry or wet situations from eastern North Carolina to Florida and sometimes cultivated throughout the South Atlantic States for ornament.

2. **Sabal Mexicana** Mart. Palmetto. A tree reaching a height of 30°-50° feet with diameter of 2½°. Leaves 5°-6° in length and 7° in diameter, lustrous yellowish green. Fruit 2-3 lobed, ripening in the summer. Flowers in the axils of persistent bracts.

Rich bottom lands near the mouth of the Rio Grande and southward. Frequently planted as an ornamental tree in the cities along the Rio Grande.

JUGLANDACEAE Lindley. Walnut Family. Large aromatic trees with alternate, odd pinnate leaves. The flowers are monoecious, the staminate borne in catkins, the pistillate solitary or in clusters at the ends of branches. Fruit a nut borne inside a dry husk which is dehiscent or indehiscent.

Husk indehiscent, nut with numerous rough projections or furrows..... 1. Juglans.

Husk dehiscent into four segments, nut more or less angled but smooth..... 2. Hicoria.

1. **Juglans** L. The Walnuts. Large aromatic trees with alternate odd pinnate leaves, furrowed bark, and a rough, sculptured nut which is produced inside a fibrous, indehiscent husk.

Leaflets 15-23; nut irregularly ridged and prominently sculptured..... 1. J. Nigra.

Leaflets 9-23; nut deeply grooved..... 2. J. rupestris.

Leaflets 11-17; nut inconspicuously grooved..... 3. J. Californica.

1. **Juglans nigra** Linnaeus. Walnut. Black Walnut. One of the grandest and most valuable of our forest trees, reaching a height of 100° to 150° and trunk diameter of 4°-6° with straight trunk, stout branches, and thick, furrowed bark. Leaves 12'-28' long; leaflets 12-23, ovate-lanceolate, glabrous above, pubescent below. Nut nearly round, somewhat flattened, $1\frac{1}{8}'$ to $1\frac{1}{2}'$ in diameter. The kernel is sweet and edible.

In well drained soil from Ontario south to the Gulf States and west to Nebraska and Texas. Because of the value of the nuts and of the wood, the black walnut has been a favorite tree and is frequently planted throughout its range.

The wood is heavy, hard, strong and rather coarse. The heart wood is a beautiful dark brown, and takes a high polish. It is much sought by furniture makers and is used extensively in the manufacture of ornaments and for gun stocks. The supply of available timber has been almost exhausted. The tree has been planted extensively for ornament, but does not make a very satisfactory shade tree.

2. **Juglans rupestris** Engelm. Texan Walnut. A forest tree 50° in height but in our area usually much smaller. The upright growing branches form a narrow stiff crown. The bark on young trees is thin and pale, becoming deeply furrowed and broken on the older portions. Leaves 7'-15' long, with 9-23 short stalked, ovate-lanceolate leaflets which are $2\frac{1}{2}'$ -5' in length by $\frac{1}{3}'$ - $1\frac{1}{2}'$ in width. The leaflets are dark yellow green, glabrous or pubescent along the midribs, finely serrate, somewhat curved with a rounded base. Fruit globose to oblong $\frac{1}{2}'$ to $1\frac{1}{2}'$ in diameter with a thin husk; nut globose and with deep prominent ridges, sweet and edible.

Extends from the limestone regions of western Texas to Arizona, New Mexico, and northern Mexico. In Texas it occurs along stream banks of the limestone area, reaching its maximum size in the canyons.

The trees of our area are small and of little economic importance. The wood is hard, close-grained, weak, dark brown in color. The tree is occasionally planted for ornament, and grows well in localities outside its natural range.

3. **Juglans Californica** Wats. California Walnut. A stately forest tree reaching 60° in height by 18'-20' in diam-

eter, frequently much smaller, with stout branches, somewhat drooping and forming a beautiful, rounded, symmetrical crown. Leaves 6'-9' long. The leaflets are long pointed, sharply serrate, rounded or heart-shaped at base, sessile, glabrous or bearing tufts of hair in the axils of primary veins. Fruit globose $\frac{3}{4}$ '-1 $\frac{1}{4}$ ' in diameter with thin husk. The nut is globose without prominent ridges; the seed is sweet and edible.

Extends from the valley of the Colorado through western Texas to California.

The wood is dark brown or mottled, hard, coarse grained; used in the manufacture of furniture. The tree is useful for ornamental planting. It has been greatly improved by hybridization with the European walnut to produce a beautiful thrifty, quick growing tree,—the Burbank walnut.

2. **HICORIA** Rabinesque. The Hickories.

Large, fine forest trees with very hard, tough, elastic wood, and hard, fissured, tight, or scaly bark. The young branches are flexible and not easily broken. The leaves are alternate, deciduous, odd-pinnate with serrate margins. Fruit a hard bony nut surrounded by a woody husk which separates at maturity into four segments. Staminate flowers clustered, usually on the wood of the preceding year; the pistillate in spike-like clusters at the ends of the wood of the present season.

1. Bud scales few, valvate (in pairs), fruit with more or less prominent ridges at the sutures of the husk, shell thin except in (3).

(1) Leaflets 9-17, usually about 13; nut ovate-oblong, circular in cross section, kernel sweet and edible..... 1 H. pecan.

(2) Leaflets 7-11, nut oblong, elliptic in cross section; kernel bitter..... 2 H. Texana.

(3) Leaflets 5-9; shell of nut very thick

(5) Leaflets 7-11; nut flattened, sometimes broader than long..... 3 H. myresticaeformis.
4 H. aquatica.

(4) Leaflets 9-13; nut corrugated..... 5 H. cordiformis.

2. Bud scales numerous, imbricated, fruit not winged as above. The shell of the nut is always thick and bony.
 - (1) Bark separating from trunk in shaggy plates, leaflets 5-7..... 6 *H. ovata*.
 - (2) Bark not separating as above;
 - a. Leaflets 7-9..... 7 *H. alba*.
 - b. Leaflets 5-7..... 8 *H. glabra*.

1. **Hicoria pecan** (Marsh) Britton. Pecan. A tall tree 100° to 170° in height and 6° in diameter with an enlarged, buttressed base. Trees growing in the open have a rounded crown which is widespreading. Leaves 12' to 20' in length with 9-17 leaflets which are lanceolate, long pointed, curved, serrate $2\frac{3}{4}$ '-6' long, rounded, or wedge-shaped at the unequal base, hairy when young, becoming smooth with age. Fruit in clusters of 3-11, oblong $1\frac{3}{8}$ '- $2\frac{3}{8}$ ' long, the husk splitting to below the middle. The nut is ovoid to ovoid-oblong, reddish brown, nearly cylindrical.

In the Mississippi valley from Indiana to Iowa, south to Alabama and Texas. In Texas it occurs along streams central and southwestern.

The wood is heavy, hard, but not strong and is less valuable than the other hickories. The nuts are the most valuable of the hickories, and are an important article of commerce. Many improved varieties are now known and are being extensively planted. The native trees are frequently budded with the more desirable varieties. Pecans are also desirable shade trees in certain cities of the state, but they are rather slow growers for this purpose, and do well only in soils that are adapted to them. They are also difficult to transplant.

2. **Hicoria Texana** (Leconte) Britton. Bitter Pecan. Texan Pecan. A forest tree 100° high and 3° in diameter, but generally much smaller,—15° to 25° tall and 8'-10' in diameter, with a narrow, rounded crown. Leaves 10'-12' long with 7-11, occasionally 13, lanceolate, pointed, serrate, leaflets, which are curved, almost sessile, hairy at first, becoming smooth, 3'-5' long, $1\frac{1}{2}$ wide. Fruit clustered $1\frac{1}{2}$ ' to 2' long, with a thin husk. The nut is oblong-ovoid, pointed at both

ends, somewhat flattened, wrinkled with a thin shell. The seed is extremely bitter.

Occurs only in Texas, reaching its maximum size along the Brazos and extending throughout the low, wet woods of eastern Texas, 100 to 150 miles inland from the coast.

The wood is tough, close-grained, and strong. It is used for fuel.

3. *Hicoria myristicaeformis* (Micheaux) Britton. Nutmeg Hickory. Bitter Walnut. Tall straight trees 100° high and 2° in diameter with a narrow rounded open crown. Twigs slender, bark $\frac{1}{2}$ ' to $\frac{3}{4}$ ' thick, close shallowly fissured. Leaves 7'-14' long with pubescent petioles, leaflets 5-11, ovate to ovate lanceolate, almost sessile, sharp-pointed, coarsely serrate, dull green above, pale, lustrous, and somewhat hairy beneath, 4'-5' long, $1\frac{1}{2}$ ' wide. Fruit cylindrical or slightly obovate, prominently 4-ridged with a thin husk. The nut is pointed at both ends, without grooves, 1' long by $\frac{3}{4}$ ' broad, resembling a nutmeg. The shell is very thick and bony.

Borders of swamps and streams from South Carolina to Alabama, Mississippi, Arkansas, and Texas. In Texas it extends as far west as Mexico.

The wood is tough and strong, close grained, with a relatively large proportion of sap wood. It is used for fuel, and in the manufacture of machinery. The tree is desirable for ornamental planting.

4. *Hicoria aquatica* Britton. Water Hickory. Bitter Pecan. A tree 80'-100' high with trunk diameter of 2', usually much smaller. The slender upright branches form a narrow crown. Leaves 9'-15' long with 7-13 ovate lanceolate, almost sessile, long pointed leaflets, 3'-5' long, $\frac{1}{2}$ '- $1\frac{1}{2}$ ' wide. Bark brown, separating in thin appressed scales, rather roughish in appearance, somewhat reddish. Fruit clustered, oblong $1\frac{1}{2}$ ' long, with prominent ridges. Nut 1' long $\frac{3}{4}$ ' broad, pointed at the ends, flattened, 4-angled with a thin shell. Kernel very bitter.

In river swamps and wet situations from Virginia to Illinois, and south to Florida and Texas, extending to the valley of the Brazos.

The wood is strong, but rather brittle and soft. It is used principally for fuel.

5. **Hicoria cordiformis** (Wagenheim) Britton. Pignut. Pig Hickory. Tight Bark Hickory. A forest tree 100° high and 2°-3° diameter, with stout branches, widespreading crown, and tight, thin, light gray bark which sometimes separates to form thin plates. Twigs when young, thin and hairy, becoming brown and smooth with age. Leaves 6'-10' long, the main axis somewhat hairy, with 5-9 leaflets. The leaflets are lanceolate to oblong or obovate, 2'-6' long, smooth above, hairy beneath, somewhat curved, unequal at base. Fruit globose $\frac{3}{4}$ '-1 $\frac{1}{2}$ ' long, 4-winged from the apex to the middle, husk thin, about 1-16 inch, covered with yellow scurfy pubescence, tardily dehiscent. Nut ovoid or oblong, somewhat flattened, sometimes broader than long, with thin and brittle shell. Kernel very bitter.

Quebec west to Minnesota, south to Florida, and west to Texas. In moist soils to the Trinity valley.

The wood is tough, heavy, strong, and durable. Used for vehicles and machinery.

6. **Hicoria ovata** (Miller) Britton. Shellbark Hickory. Scaly Bark Hickory. Red Hickory. A large forest tree 100° or more in height and 3°-4° diameter. Bark or trunk separating in thin, long, flat plates, light gray or darker. Leaves 8'-14' long with 5-7, generally 5, leaflets. The leaflets are ovate to ovate-lanceolate, 4'-7' long, the lateral sessile, the terminal stalked. Fruit subglobose, or obovate, depressed at the apex, 1'-1 $\frac{1}{2}$ ' long. The husk is thick and the segments split freely to the base. Nut variable in shape and size, oblong, subglobose, or obovoid, somewhat flattened and wrinkled. Shell rather thin. Kernel sweet and edible, used extensively for food.

Quebec to Minnesota and Kansas, and extending south to Florida and Texas. In Texas it occurs in rich moist soils of the eastern portion.

The wood is hard, strong, and elastic. It is used in the manufacture of vehicles, and machinery. The nut is an important article of commerce.

7. **Hicoria alba** (Linnaeus) Britton. White Hickory.

Mocker Nut. A large handsome forest tree with maximum height of 100° and trunk diameter of 3°, but usually much smaller, with light gray, fissured bark which is never scaly. Leaves with a resinous odor, 8'-12' long, with 5-9, generally 7 leaflets; leaflets oblong lanceolate, or obovate-lanceolate, sessile or the terminal one short-stalked, pointed at the apex, hairy at first, but becoming smoother with age. Fruit subglobose, elliptic, 1½'-2' long, with a thick husk which splits to the base. Nut globose to elliptic, smooth, without prominent angles; shell thick, kernel sweet and edible.

Ontario south to Florida and west to Texas, extending to the valley of the Brazos.

Wood and uses similar to *Hicoria ovata*.

8. *Hicoria glabra* (Mill.) Britton. Pignut. Black Hickory. A tall forest tree 80°-90° high and 3°-4° in diameter with narrow crown, somewhat pendulous branches, and bark of trunk usually dark gray to almost black, tight, fissured, with narrow furrows. Twigs slender, hairy at first, becoming smooth and reddish brown with age. Leaves 6'-9' long with smooth axis. Leaflets 3-9, more commonly 5-7, 2½'-6' long, pointed, hairy when young, smooth or with a few hairs in the axils of the veins when mature, unequal at base. Fruit obovoid or globose somewhat pear-shaped, 1¼' long; husk thin; nut obovoid to elliptic, smooth, shell thick, kernel sweet or bitter.

Maine to Nebraska, south to Florida and west to Texas. Extends to the valley of the Nueces.

Uses similar to *H. ovata*.

LEITNERACEAE Drude. Cork Wood Family.

Leitnera Floridana Chapm. A shrub or small slender tree sometimes 20° high and 4'-5' in diameter, with dark gray fissured bark about 1-16' thick. Leaves alternate, somewhat leathery, deciduous, 4'-6' long, 1½'-2½' wide with petiole 1'-2' in length, margin entire or somewhat wavy, but not serrate, pointed at the apex, equal and gradually narrowed at base, bright green and smooth above, hairy beneath. Flowers in aments, the male and female on different plants. Stamen

bearing aments clustered at the ends of branches, pistils bearing aments scattered on the stem. Fruit a compressed dry brown drupe, solitary or in clusters of 2-4, ripening before the leaves are mature, $\frac{3}{4}$ ' long, $\frac{1}{4}$ ' wide.

Swamps of Florida, Texas and southeastern Missouri. In Texas it occurs in swamps of the Brazos River.

The wood is lighter than any other in our area. It is frequently used for floats of fishing nets.

MYRICACEAE Dumort. Bayberry Family.

Morella cerifera Linnaeus. Wax Myrtle. Bayberry. A fragrant shrub or small tree occasionally reaching a height of 40° and trunk diameter of 8'-10', but usually much smaller, shrubby and forming dense thickets. Bark smooth, light gray, about $\frac{1}{4}$ ' thick. Leaves alternate, simple, thick, firm, evergreen, fragrant, oblanceolate or oblong-spatulate, sparingly notched or entire, $1\frac{1}{2}$ '-4' long, glandular on both surfaces, hairy beneath. Flowers in aments appearing about the end of March, staminate and pistillate borne on different plants. Fruit short spikes of dry, ovoid drupes covered with waxy coating.

New Jersey, Delaware, Maryland, Florida, Arkansas, Mississippi and Texas.

The wood is soft, brittle, and used only for fuel. The wax which occurs on the fruit is sometimes collected and used for candles.

SALICACEAE Lindley. The Willow Family.

Trees or shrubs with alternate, simple leaves with or without stipules. Flowers borne in catkins appearing before or with the leaves, staminate, and pistillate on different trees. The fruit is a dehiscent capsule containing numerous seeds, each with a dense tuft of long, silky, white hairs at the apex.

Leaves less than twice as long as broad, winter

buds with numerous scales..... 1. *Populus*.

Leaves more than twice as long as broad, winter

buds with one outer scale..... 2. *Salix*.

1. **POPULUS** L. The Poplars.

Large, rapidly growing forest trees with large, scaly, resinous buds; pale, furrowed bark; alternate, toothed or lobed leaves, and flowers borne in catkins.

Petiole of leaf round, scarcely or not at all flattened laterally, buds cottony, leaves more or less lobed 1. *P. alba*.

Petiole of leaf flattened laterally, leaves with margins notched or toothed, but not lobed.

Leaves broadly deltoid, abruptly sharp pointed at the apex.

Leaf blades for the most of the leaves longer than broad..... 2. *P. deltoides*.

Leaf blades mostly broader than long.

Leaves truncate and slightly cordate at base with many small teeth..... 3. *P. Fremontii*.

Leaves more or less cuneately narrowed on the petiole with few teeth which are relatively larger than the preceding... 4. *P. Wislizeni*.

1. *Populus alba* L. White Poplar. Silver-leaf Poplar. A large tree with height of 100° and trunk diameter of 3° or frequently much smaller, with numerous suckers developing from the roots. Bark on young trees smooth, gray, or a greenish white; on old trees furrowed, gray or brown. Leaves ovate or triangular, irregularly toothed, or 3-5 lobed, pointed, firm, densely white, velvety, hairy beneath when young becoming smoother with age. The leaf petiole is almost round, sometimes flattened somewhat laterally, shorter than the blade of the leaf.

Introduced from Europe. It is cultivated throughout a large portion of the state for ornament.

The silver poplar grows rapidly, is adapted to a wide range of soils, is easily propagated and stands pruning well. It is planted in many localities as an ornamental tree, for which purpose it is perhaps the most valuable of the poplars.

2. *Populus deltoides* Marshall. Cottonwood. Carolina Poplar. Necklace Poplar. A large tree 120° or more in height and 6°-8° in diameter, found principally along stream banks. Bark gray with a greenish cast, thin and smooth on young twigs, and branches, thick and fissured on old branches and

trunk. Leaf with flattened petiole, blade about $1\frac{1}{2}$ '-5' long and almost as wide, coarsely toothed, teeth incurved, glandular, veins prominent on both surfaces. Flowers borne in catkins appearing before the leaves. The staminate catkins $1\frac{1}{2}$ ' long, the pistillate $1\frac{1}{2}$ '-2' long before the fruit ripens, becoming 3'-4' long as the fruit develops.

Quebec to Florida and west to the Rocky Mountains. It grows in moist soils along lakes and streams.

The wood is principally sap wood which is light, soft, and weak. It warps badly, and is dried only with difficulty; used principally for box boards, siding, sheeting, excelsior, and pulp. The supply has been almost exhausted. The cottonwood is sometimes planted as an ornamental tree, but this is to be recommended only where a quick growing shade, or windbreak must be had at the sacrifice of more desirable slower growing varieties.

3. *Populus Fremontii* Watson. Cottonwood. A tree 100° in height and 5°-6° in diameter with a rather broad, open crown and short trunk. Bark on young branches, light gray brown, thin and smooth; on older parts, thick, dark brown with reddish tinge, and deeply fissured. Leaves deltoid or reinform, 2'-2 $\frac{1}{2}$ ' long, 2 $\frac{1}{2}$ '-3' broad. Coarsely serrate, with 4-12 incurved glandular tipped teeth on each side.

A western form extending from California eastward to Nevada, and south to Texas. It occurs along water courses throughout the western part of the state.

Its uses are similar to *Populus deltoides*.

4. *Populus Wislizeni* Sarg. Cottonwood. Occurs in the valley of the Rio Grande from El Paso to the Gulf. It is distinguished from *P. Fremontii* by the greater length of the flower pedicel, and the more sharply pointed leaves.

2. **SALIX** L. Willow.

Trees or shrubs with soft wood, simple, alternate leaves which are elongated, pointed, deciduous, without lobes, usually serrate. Flowers in catkins appearing before or with the leaves. Staminate and pistillate flowers borne upon different trees. Fruit a dehiscent capsule containing many seeds which

bear a tuft of long silky hairs at the apex. Found principally in damp situations. There are so many hybrids and introduced species that the classification of the willows is difficult and sometimes impossible. The following key includes the forms which are known to occur in our area.

Branches decidedly drooping..... 1. *S. babylonica*.

Branches not decidedly drooping.

Leaves small, $1/3$ - $1\frac{1}{3}$ ' long, entire or nearly so,

pale green on both sides..... 2. *S. taxifolia*.

Leaves long, 4'-7', silvery white below..... 3. *S. longipes*.

Leaves green on both surfaces, 3'-6' long, $\frac{1}{8}$ '- $\frac{3}{4}$ '

wide, narrowly lanceolate, long-pointed..... 4. *S. nigra*.

Leaves pale, or glaucous below, $2\frac{1}{2}$ '-4' long,

$\frac{3}{4}$ '- $1\frac{1}{4}$ ' wide, broadly lanceolate..... 5. *S. amygdaloides*.

Leaves linear, lanceolate green on both surfaces,

2'-6' long, $\frac{1}{8}$ '- $1/3$ ' wide..... 6. *S. interior*.

1. ***Salix babylonica* L.** Weeping Willow. An ornamental tree which has been introduced from Asia and is grown quite extensively throughout North and South America. Its distinguishing mark is the drooping habit of its branches from which its name is derived. Sometimes reaching a height of 60' and a trunk diameter of 3°-5°, with bark on old parts gray, rough and fissured. The young twigs are green, slender, and drooping. Leaves linear to linear lanceolate, pointed, pale green below. It is used only as an ornamental shade tree.

2. ***Salix taxifolia* H. B. K.** Willow. Yew Leaved Willow. A tree sometimes reaching a height of 40°-50° and trunk diameter of 18', with broad open crown, light gray-brown, fissured bark, $\frac{3}{4}$ '-1' thick, covered with small scales. Leaves smaller than any of the other species of willow, $1/3$ '- $1\frac{1}{3}$ ' long, $1/12$ '- $1/8$ ' wide.

Arizona southward through western Texas and Mexico to Guatemala. It is sometimes planted for ornament.

3. ***Salix longipes* Anderson.** Ward's Willow. Trees reaching a height of 30° and trunk diameter of 6'-8', with thick, brown, rough bark divided into angular plates, hairy and reddish brown on young twigs. Leaves lanceolate to ovate lanceolate, somewhat pointed at the apex, round or heart-shaped at base, bright green and smooth above, pale and glaucous or hairy beneath. Flowers in April and May.

Maryland to Kentucky, and Missouri, south to Florida, Texas, New Mexico, and Mexico.

The wood is weak, soft, and rather dark brown and of little economic value.

4. **Salix nigra** Marsh. Black Willow. A tree reaching a maximum height of 100°, and diameter of 3°, but commonly much smaller,—30°-40°. The crown is wide spreading. Bark of trunk rough, thick, flaky, dark brown or nearly black on old portion, shoots hairy at first green or greenish brown, becoming brown and smooth with age. Leaves narrowly lanceolate, long pointed, bright green above, paler and smooth beneath, closely serrate, sometimes with hairs along veins. Flowers in April and May.

New Brunswick west to North Dakota, south to Florida and west to Texas. Grows along stream banks.

The wood is light, soft, warps badly, and has not been of much economic importance.

5. **Salix amygdaloides** Anders. Peach Willow. Almond Willow. A tree reaching 60°-70° in height and 2° in diameter. Regarded by some as a variety of *S. nigra*. Bark of trunk fissured, 1/2' to 3/4' thick, brown tinged with red. Young twigs smooth, orange to reddish brown, brittle. Leaves lanceolate to ovate lanceolate, somewhat curved, long pointed, light green above, pale and glaucous beneath, closely serrate. Flowers earlier than the preceding species.

Quebec west to Manitoba, southward to Ohio and westward to the Rocky Mountains, extending to southwestern Texas. Common along the Rio Grande from El Paso northward.

Too rare to be of much importance. The wood has been used in the preparation of charcoal.

6. **Salix interior** Rowlee. Sand Bar Willow. A shrub, or sometimes a tree reaching 40°-50° in height, but usually not over 20°. Sometimes forming thickets. The bark is brown, rather thin, 1/8'-1/4', and almost smooth. The young twigs are slender, smooth, or with fine hairs, reddish, becoming brown with age. Leaves linear lanceolate, often falcate, pointed at both ends, light yellowish green, darker on upper than on lower surface, remotely notched with projecting teeth. Petiole of the leaf grooved 1/8'-1/4' long.

Along streams and sand bars from Quebec southward, Virginia, Kentucky, Nebraska, and Texas. In Texas it is found west of the Pecos River.

Economic uses similar to *Salix amygdaloides*.

CORYLACEAE Mirbel. Hazel Nut Family.

Small trees with close grained, hard wood, and smooth or scaly bark. Leaves simple, alternate, deciduous, straight veined and doubly serrate. Flowers borne in catkins in the early spring.

Bark on main trunk smooth..... 1. *Ostrya*.
Bark on main trunk ridged..... 2. *Carpinus*.

1. **OSTRYA** Scap. Hop Hornbeam.

1. ***Ostrya Virginiana*** (Mill) Willd. Ironwood. American Hop Hornbeam. A small tree usually 20°-30° high with trunk



Fig. 7. *Ostrya Virginiana*.

diameter of 18'-20'. The branches are long, slender, and drooping, forming a rounded open crown. Bark brown, thin and

shreddy on trunk and older branches, green and hairy on young twigs. Leaves ovate to lanceolate, acute at the apex, rounded, wedge-shaped, or heart-shaped at base, sharply, doubly serrate, $2\frac{1}{2}$ '-4' long, thin and tough. Flowers borne in catkins in early spring. Fruit hop-like, 2 to 3 times as long as wide, consisting of bladder-like bracts which enclose the nuts.

Valley of the St. Lawrence, south to Florida and west to Texas, Ontario, Minnesota, South Dakota and Kansas. It is found principally in dry soil in thick woods.

The wood is very hard, tough, close grained. It is used for fuel, fence posts, tool handles, and mallets. The small size of the tree makes it of little economic importance. It is sometimes planted for ornament.

2. **CARPINUS** L.

1. **Carpinus Caroliniana** Walt. American Hornbeam. Water Beech. Blue Beech. Small trees with fluted or ridged trunk rarely 40° high with diameter of 2°. Bark smooth, close, gray on older parts, hairy and green on young twigs. Leaves ovate to oblong, pointed, doubly serrate, somewhat unequal-sided, hairy when young, smoother with age, dull bluish green above, yellowish beneath. Flowers borne in catkins in early spring. The nut is $\frac{1}{3}$ ' long, ovoid, flattened and ribbed. The scales are leaf-like, three-lobed, the lateral lobes much shorter than the terminal.

Nova Scotia to Florida, west to Ontario, Minnesota, Kansas, and Texas. It occurs in moist woodlands, and along streams, but may also be found in dry woodlands. It grows principally in the shade of larger forest trees.

The wood is heavy, hard, tough, but the small size of the tree and the crookedness of the stem renders it of no economic importance for timber. It is sometimes planted for ornament.

BETULACEAE (Tournefort) L. Birch Family.

Monoecious, aromatic trees or shrubs with simple, alternate, straight veined, usually serrate leaves. Flowers borne in catkins, opening in the early spring usually before the leaves.

The fruit is a leafy scaled catkin or a woody cone-like aggregate of bracts. Bark smooth, shining, usually scaling away in thin plates.

Bracts of the fruit forming a woody, persistent
cone 1. *Alnus*.
Bracts of the fruit membranous deciduous with
the nut..... 2. *Betula*.

1. *ALNUS* L. Alder.

Alnus rugosa (Du Roi) K. Koch. Smooth Alder. A shrub or small tree sometimes reaching a height of 30°. Bark thin, smooth, brown. Leaves 2' to 4½' long, thick, obovate, oval, blunt, or rounded at the apex, sharply serrate, dark green above. Nut ovate, sharply margined without wings.

Maine to Minnesota, Florida and Texas. Usually along streams. The trees are too small to be of value for timber. The wood is used for fuel and for charcoal.

2. *BETULA* L. Birch.

Betula nigra L. Birch. Water Birch. Red Birch. A large forest tree reaching a height of 80°-90° and trunk diameter of 5°. The branches are slender and the crown is narrow. Bark on branches thin, smooth, reddish brown, or silver gray, peeling off in thin layers; on main trunk thick, reddish brown, scaly. Leaves rhombic-ovate, irregularly doubly toothed or sometimes lobed, 1½'-3' long, dark green and lustrous above somewhat hairy beneath, or smooth except along the veins. Flowers opening before or with the leaves.

Massachusetts to Minnesota and Kansas, Florida and Texas. Chiefly along banks of streams, ponds, and swamps. In Texas it extends to the Trinity Valley.

The wood is hard, strong, light brown. It is used for furniture, and for fuel.

FAGACEAE Drude. The Beech Family.

Monoecious trees with watry juice; leaves alternate, pinnately veined, mostly deciduous; staminate flowers in elon-

gated catkins, or rounded heads, pistillate flowers, solitary or clustered. Fruit a one-seeded nut, borne in a prickly bur or seated in a woody, scaly cup. This is the most important economic group of trees occurring in the state.

Staminate flowers borne in rounded heads; nut triangular, borne inside a woody husk armed with recurved prickles..... 1. *Fagus*.

Staminate flowers in elongated slender catkins.

Nut borne inside a closed woody husk, but armed with straight prickles..... 2. *Castanea*.

Nut seated in a scaly, woody cup..... 3. *Quercus*.

1. **FAGUS** (Tournefort) L. Beech.

Fagus Americana Sweet. The Beech. A tree usually about 70° to 80° in height, but sometimes larger. The lower branches are drooping, the middle almost horizontal, while the upper are ascending, forming a rather narrow crown. Bark light gray, thin, and smooth. Winter buds about one inch long, taper pointed, with light brown scales. Leaves ovate to oblong-ovate, usually rather long taper-pointed with a wedge-shaped or sometimes heart-shaped base. The margin of the leaf is regularly minutely serrate, the veins ending in the apex of the teeth, smooth above, minutely hairy or smooth below. Nuts $\frac{3}{8}$ '- $\frac{1}{2}$ ' long, triangular, reddish brown, quite hairy.

Nova Scotia to Ontario and Wisconsin, extending south to the Gulf States and west to Texas. In Texas it extends to the Trinity River.

The wood is hard, strong, tough, close grained, takes a high polish. It is used for building material, fuel, staves, and heading. The nut is sweet and edible. The tree is not well adapted for ornamental purposes, because the roots grow near the surface, and grass does not thrive under it.

2. **CASTANEA** (Tournefort) Adanson. The Chestnut.

Castanea pumila Miller. Chinquapin. A shrub or medium sized round topped tree 50' high with spreading slender branches, furrowed scaly bark. Leaves obovate, thick, firm, rounded or pointed at the apex, wedge shaped or sometimes unequal at the base, sharply toothed, 3'-4' long, $1\frac{1}{2}$ '-2' wide,

yellowish green, lustrous above, paler and somewhat hairy beneath. Flowers in long catkins. Fruit a closed woody bur with straight prickles ripening in the autumn and opening with the first frosts. Nut compressed sharp pointed $\frac{3}{4}$ '-1' with sweet edible seed.

Pennsylvania, Florida, Missouri and Texas.

The wood hard, strong, close grained, light with little sap wood. It is used for railroad ties and fence posts.

3. **QUERCUS** (Tournefort) L. The Oaks.

Large forest trees or shrubs with simple, alternate deciduous or evergreen leaves which are entire toothed or lobed. The leaves are rather thick and woody and remain on the tree either throughout the winter or until nearly all other deciduous leaves have fallen. The staminate flowers are borne in long, slender, pendulous catkins, the pistillate solitary or in clusters. The fruit is a nut borne in a shallow woody cup. In the so-called white oaks, the fruit ripens the first year, while in the black oaks, it does not mature until the second. The oaks comprise more species than any other genus of trees within our area, and are frequently difficult to identify with certainty, as a number of the species readily hybridize. The oak is one of our most valuable sources of timber, furnishing a large part of the hard woods. It is also cultivated extensively for shade and ornament.

- | | |
|--|------------------|
| I. Mature leaves, entire, notched or lobed, rarely
bristle tipped; fruit maturing the first
season | White Oaks. |
| A. Leaves deciduous. | |
| 1. Leaves lobed, the lobes rounded, never
tipped with bristles. | |
| a. Leaves smooth beneath, 3-9 lobed.. | 1 Q. alba. |
| b. Leaves hairy beneath. | |
| (1) Leaves oblong-obovate, usually 5-
lobed with stellate hairs above.. | 2 Q. stellata. |
| (2) Leaves deeply lobed, cup fringed
by the awned scales..... | 3 Q. macrocarpa. |
| (3) Leaves deeply 5-9 lobed, nut
often nearly enclosed in the cup | 4 Q. lyrata. |
| 2. Leaves straight veined, variously
toothed or notched, but not deeply | |

lobed (Chestnut Oaks).

a. Acorns sessile.

- (1) Leaves obovate, small tree or shrub 5 *Q. prinoides*.
 (2) Leaves oblong to lanceolate, sometimes obovate..... 6 *Q. Muhlenbergii*.

b. Acorns borne upon stalks about as long as the leaf petiole.

- (1) Leaves densely hairy below.... 7 *Q. Michauxii*.
 (2) Leaves smooth below..... 8 *Q. Brayii*.

3. Leaves entire, undulate, or lobed only near apex.

a. Cup saucer-shaped, thin, leaves hairy beneath 9 *Q. Durandii*.

b. Cup saucer-shaped, leaves smooth, cup thick..... 10 *Q. Laceyi*.

B. Leaves persistent until the appearance of the new leaves of the following year, mostly evergreen.

1. Leaves entire on mature branches, sometimes serrate on young twigs, dark green, southeastern species..... 11 *Q. Virgiana*.
 2. Leaves spinulate toothed to entire, dark green, western species..... 12 *Q. Emoryi*.
 3. Leaves sinuate lobed not toothed..... 13 *Q. breviloba*.
 4. Leaves light or blue green, hairy beneath when old, entire wavy or lobed.. 14 *Q. undulata*.
 5. Leaves light or blue green, smooth beneath when old, entire wavy or lobed.. 15 *Q. oblongifolia*.

II. Leaves or their lobes mostly tipped with bristles, fruit maturing the second season.. Black Oaks.

A. Leaves persistent, densely white, downy beneath 16 *Q. hypoleuca*.

B. Leaves deciduous.

1. Leaves deeply cut or lobed.

a. Leaves lobed to about the middle, lobes wedge shaped; cup of acorn, saucer shaped, thick, about $\frac{3}{4}$ -inch broad 17 *Q. rubra*.

b. Leaves lobed to beyond the middle or sometimes a few of them not as deeply lobed.

- (1) Cup of acorn saucer shaped, thin, enclosing the nut for about $\frac{1}{3}$ its length; leaves dull above, cup about $\frac{3}{4}$ ' broad..... 18 *Q. Schneckii*.

- (2) Cup top-shaped or hemispheric, enclosing the nut generally about $\frac{1}{2}$ its length.
 - (a) Inner bark bright orange, scales of the cup large, forming a loose margin.... 19 *Q. velutina*.
 - (b) Inner bark gray, reddish, or yellow, cup less than $\frac{3}{4}$ broad 20 *Q. Texana*.
- c. Leaves irregularly lobed with a gray or rusty pubescence beneath..... 21 *Q. digitata*.
- d. Leaves obovate with 3-5 lobes above the middle.
 - (1) Leaves hairy beneath..... 22 *Q. Marylandica*.
 - (2) Leaves smooth beneath..... 23 *Q. nigra*.
- 2. Leaves entire or with few teeth.
 - a. Leaves smooth beneath, sharp pointed, cup very flat..... 24 *Q. Phellos*.
 - b. Leaves hairy beneath, cup saucer shaped 25 *Q. cinerea*.

1. **Quercus alba** Linnaeus. White Oak. A large forest tree usually 60°-80° in height and trunk diameter of 4° but frequently larger. Trees growing in the open are rather low with round full crown, crowded in the forest they become tall and without branches except at the extreme top. The bark is a light gray, sometimes tinged with brown, flaky without deep fissures except on the lower part of the main trunk. Leaves obovate to oblong, 4'-8' in length, wedge-shaped at base, 3-9 usually 7 lobed, the lobes entire or with one or two secondary lobes, pale and smooth beneath, bright or dull green above. Flowers appearing before the leaves have reached more than one-fourth their mature size. Acorns stalked or sessile, ovoid to oblong, the cup enclosed from $\frac{1}{4}$ to $\frac{1}{3}$ of its length.

Southern Maine, Ontario, west to Minnesota and south to Florida and Texas. In Texas it extends to the valley of the Brazos.

The wood is heavy, hard, close grained and is very tough, durable, and strong. The heart wood is light brown, the sap wood light. The medullary rays are prominent and the quarter sawed wood is extensively employed in the manufacture of furniture. It is the most valuable timber tree of America.

The wood is used in general construction, finishing, cooperage, wagon and carriage stock, agricultural implements, rail-



Fig. 8. *Quercus alba*.

road ties, fence posts, baskets and fuel. The tree is one of great beauty and has no undesirable habits. It is, however,

a slow grower, and is difficult to transplant. It would not be advisable to attempt to cultivate it very far from its natural range. The soil should be rich, moist, well drained. Wherever the tree can be successfully grown its planting should be encouraged.

2. **Quercus stellata** Wangenheim. Post Oak. A large forest tree reaching 100° in height with diameter of 2°-3°, but generally smaller. The branches are widespreading, forming a



Fig. 9. *Quercus stellata*.

rounded crown. Bark about one inch thick, reddish, furrowed on main trunk, smooth on young twigs. Leaves obovate, 5-lobed, the middle pair of lobes much larger than the basal, the notch between the lower and middle lobes very deep and wide. The lower lobes are rounded, the upper two or more with secondary lobes. The leaves are thick, firm, dark green above with light stellate hairs, densely hairy beneath with light yellow or silvery hairs. Acorn ovoid about $\frac{1}{2}$ ' long, $\frac{1}{3}$ to $\frac{1}{2}$ enclosed in the saucer shaped cup.

Massachusetts to Pennsylvania, west to Missouri, south to Florida and Texas. In Texas it extends to the central part of the state. Most abundant in sandy or sterile soils. It is by far the most abundant of any of the oaks in Texas.

The wood is heavy, hard, close grained, durable. It is used for fence posts, cross ties, building material, and fuel. The tree is often planted for ornament, but does not thrive well in heavy soils and is a slow grower.



Fig. 10. *Quercus macrocarpa*.

3. **Quercus macrocarpa** Mischeaux. Burr Oak. Mossy Cup Oak. A large stately forest tree which in its maximum size may reach a height of 170° with trunk diameter of 6°-7°. It is, however, more commonly medium size 40°-60° high. The branches are stout and spreading, forming a wide open crown. Bark 1'-2' thick, gray to brown, deeply fissured. Leaves obovate or oblong, 4'-12' long, 5-9 lobed, variable, some of them barely lobed, others cut almost to the midrib, dark green and smooth above, whitish and hairy beneath. Acorn ovoid, $\frac{3}{4}$ ' to 1 $\frac{1}{4}$ ' long, one-third to almost its entire length enclosed in the cup-shaped cup. The upper edge of the cup is fringed with a mossy border made up of the awned upper scales.

Nova Scotia to Manitoba, Minnesota, Wyoming, south to Georgia, and west Texas. In Texas it extends to the Nueces River.

The wood is similar to that of *Q. alba*, both being called white oak by lumbermen. The supply of these two valuable timber trees is rapidly diminishing. There remains practically no virgin forests.

4. **Quercus lyrata** Walter. Overcup Oak. A large forest tree 100° in height and 2°-3° in diameter. The trunk is either tall, erect, or divided into several main branches which are wide spreading, and form a beautiful rounded crown. The bark is one inch or more in thickness, light gray, fissured, and scaly. Leaves obovate-oblong, 5-9 lobed, frequently cut almost to the midrib near the middle, wedge shaped at base, green and smooth above, pale and hairy beneath. Acorns sessile or short stalked, nut globose, depressed, $\frac{3}{4}$ ' long, almost completely enclosed in the rather thin reddish brown cup.

Maryland south to Florida, west to Texas, and north through Tennessee, Indiana, and Illinois. Confined principally to moist soil. In Texas it extends to the Trinity Valley. Most abundant in wet rich alluvial soils.

The wood and uses are similar to *Quercus alba*. It has been used extensively for railroad ties.

5. **Quercus prinoides** Willdenow. Chinquapin Oak. A shrub or small tree sometimes reaching a height of 15°-20°. The bark is light brown and somewhat scaly. Leaves obovate or oblanceolate, pointed or acute at the apex, wedge-shaped

or rounded at base, coarsely toothed, green and shining above, hairy beneath with grayish hairs. The acorns are sessile or very short stalked, nut ovoid to oblong $\frac{1}{2}$ ' to 1' long, light



Fig. 11. *Quercus lyrata*.

brown in color, cup hemispheric $\frac{1}{2}$ ' in diameter enclosing about one-half of the nut.

Maine to Minnesota, south to Alabama and Texas.

The trees are too small to be of value for timber. It is used for fuel.

6. **Quercus Muhlenbergii** Englemann. Yellow Oak. Tan Bark Oak. A large forest tree with maximum height of 100° and trunk diameter of 6°-7°, but usually smaller, 60°-70° high, and 3°-4° in diameter. The branches are spreading, forming a rather broad crown. The bark on old trunks is about 1½' thick, close, light to dark gray, scaly, sometimes separating in rather large flakes. Leaves with petioles ½'-1¼' long, obovate to oblong lanceolate, taper pointed, coarsely toothed, teeth incurved, glandular, hairy on both sides when young, smooth above at maturity, hairy below. Acorn ½'-¾' long enclosed for about one-third of its length by the thin, silvery gray cup-shaped cup. This tree is frequently confused with *Quercus prinus* from which it may be distinguished by the bark on the mature trunk.

Vermont to Minnesota, south to Florida and west to Texas. It is most abundant on limestone soils.

The wood is heavy, close grained, hard and strong. It is used for the same purposes as *Quercus alba*.

7. **Quercus Michauxii** Nuttall. Cow Oak. Basket Oak. A large forest tree reaching a maximum height of 100° with trunk diameter of 6°-7°. The branches are stout and upright, forming a rather narrow rounded crown. The bark is ½' to 1' thick, light ashy gray, separating into thin plates. Leaves obovate to broadly oblong with petioles ¾'-1¼' long, short taper-pointed at the apex, wedge-shaped or sometimes rounded at base, toothed, smooth and dark green above, paler and densely hairy beneath. Acorns solitary or in pairs, borne on short stalks, nut ovoid 1'-1¼' long, one-half enclosed in the scaly, pubescent, saucer-shaped cup.

Delaware to Indiana, Missouri, south to Florida and west to Texas. In Texas it extends to the Trinity Valley.

Uses similar to *Quercus alba*.

8. **Quercus Bray**i Small. Bray's Oak. A rather large forest tree attaining a height of 50° to 60° with gray, flaky bark. Leaves obovate, somewhat triangular, wedge-shaped toward the base, coarsely wavy toothed, thin, dark green

above, smooth on both surfaces, paler beneath with prominent whitish midrib and relatively few strong regular, prominent lateral veins. The acorns are borne upon short stalks, nut



Fig. 12. *Quercus Michauxii*.

oblong to ovoid, about one-third enclosed in the thin walled, warty scaled, hemispheric cup.

Occurs only in canyons of central Texas.

9. *Quercus Durandii* Buckley. Durand's Oak. A tree reaching a maximum height of 40°-50° with trunk diameter of 2°-3°. Bark light gray, somewhat scaly about $\frac{1}{2}$ '- $\frac{3}{4}$ ' thick.

Leaves entire or sometimes 5-lobed near the blunt apex, wedge-shaped at base, thick, bright, lustrous green above, pale and hairy beneath. Acorns almost sessile, cup shallow, nut ovoid somewhat depressed. Distinguished from *Quercus breviloba* by the very shallow cup.

Alabama, extending into the eastern part of Texas. It grows in dry soil of river valleys.

Similar to *Quercus alba*. The tree is also planted for ornament.

10. *Quercus Laceyi* Small. Lacey's Oak. A small tree 15°-20° high or more frequently a shrub. Bark rough, irregularly and deeply grooved, brown in color. Leaves oblong to oblong-obovate, 3-5 lobed, thick, short stalked, olive green, the upper surface has a waxy appearance while the lower is grayish and covered with minute scales, not falling until about the time the new leaves unfold. Acorns sessile or nearly so, the nut is oblong to oblong-ovoid, enclosed only at the base by the shallow saucer-shaped cup.

Limestone hills of south central Texas. Too small to be of economic importance. Used for fuel.

11. *Quercus Virginiana* Miller. Live Oak. A large evergreen tree 40°-50° high with trunk diameter of 3°-4°. The stocky stem is buttressed at the base and frequently divides a few feet above the ground into large secondary branches which are widespreading, forming a low rounded crown. Old trees are almost globular in outline. The bark is ½' to 1' thick, brown, tinged with red, somewhat furrowed, scaly. Leaves oblong, oval, or obovate, mostly blunt, sometimes short pointed, margins entire on mature branches, somewhat toothed on young branches, dark green above, pale and somewhat hairy beneath. Acorn borne singly or in clusters of two to five, short stalked; the nut is ovoid or oblong, one inch or more long, brown, shining, about one-fourth enclosed in the light brown, turbinate, hemispheric cup.

Virginia to Florida, west to Texas, and Mexico. In Texas it occurs abundantly in the coast country from the Brazos to the Nueces. It extends to the northward across the Black and Grand prairies. The tree grows in a wide variety of soils and habitats. It seems to reach its maximum development in

rather heavy clay soil but thrives well along river bottoms. It is also very drouth-resistant, attaining a considerable size on dry barren hills of central and west Texas.



Fig. 13. *Quercus virginiana*.

The wood is hard, strong, close-grained. It was formerly used in ship building. The live oak is one of the finest of our ornamental shade trees

12. **Quercus Emoryi** Torrey. Black Oak. A small round-topped tree 30° to 40° high with short trunk, stout drooping branches and slender reddish branchlets. Bark 1'-2' thick, deeply divided, dark brown. Leaves oblong, lanceolate, pointed, entire or somewhat toothed, 1'-2½' long, ½'-1' wide, thick and glossy when mature, persistent until spring. Fruit



Fig. 14. *Quercus Emoryi*.

sessile or nearly so, ripening from July to September of the first year; acorn oblong or oval ½'-¾' long, ⅓' wide, enclosed for about one-third its length in the cup-shaped cup.

On mountain sides and in canyons. New Mexico, Arizona, northern Mexico and Texas. In Texas it occurs in the Limpia and Chisos mountains.

The wood is soft, strong, brittle, close grained, dark brown. The acorns are sweet and edible, being used as food by the Mexicans.

13. **Quercus breviloba** (Torrey) Sargent. Texan White Oak. A shrub or small tree sometimes reaching a height of 25°-30°. The trunk divides near the base to form several branches. The thin, silvery, gray bark separates from the

trunk in loose, elongated plates. Leaves obovate or oblanceolate, with 5-7 shallow lobes, wedge-shaped at base, bluish green and shining above, paler and hairy beneath, remaining on the tree until the new leaves of the following spring unfold. Acorns sessile or very short stalked; nut ovoid, cup saucer-shaped, scales appressed, enclosing about one-fourth of the nut.

West Texas and Mexico. Most abundant in dry limestone soil.

The wood is used for fuel.

14. *Quercus undulata* Torrey. Shin oak. A shrub or small tree sometimes 25° - 30° high with thin scaly gray bark, and reddish brown twigs. Leaves oval to oblong 1'-3' long, $\frac{1}{4}$ '- $\frac{3}{4}$ ' wide entire or with wavy sometimes toothed margin, smooth and lustrous above, yellowish brown beneath, persistent. Fruit ripening the first season, solitary or in pairs, sessile or stalked. Acorn oval $\frac{3}{4}$ '-1' long enclosed for about one-third its length in the cup.

On dry ridges and cliffs, Colorado, New Mexico, Arizona, Utah, Nevada, western Texas, and Mexico.

15. *Quercus oblongifolia* Torrey. Blue Oak. A small tree usually not over 30° in height, and 18'-20' in diameter. It branches freely to form a rounded symmetrical crown. The bark is $\frac{3}{4}$ '-1 $\frac{1}{2}$ ' thick, light gray, scaly, the scales are close, regular. Leaves oblong, ovate or oblanceolate, entire or notched at the apex of the undulate margin, bluish green persistent until the new leaves of the following spring. Acorns are sessile or stalked; nut ovoid, dark brown, $\frac{1}{2}$ '- $\frac{3}{4}$ ' long, about one-third enclosed in the hemispheric, hairy cup.

Chisos Mountains of West Texas, extending into Mexico, Arizona, and New Mexico. The trees are small and are only used for fuel.

16. *Quercus hypoleuca* Englemann. White Leaf Oak. A shrub or small tree usually not over 30° - 40° high with round top, spreading slender branches, and rough fissured dark bark. Leaves lanceolate, elliptic or oblong lanceolate, 2'-4' long, $\frac{1}{2}$ '-1' wide, with thickened margins, entire or some of them slightly toothed, bristle tipped, yellowish green and lustrous above, whitish and wooly beneath. Fruit ripening in the sec-

ond summer, solitary almost sessile, acorn ovoid 1/2'-2/3' long about one-third enclosed in the turbinate cup.

Mountains of New Mexico, Arizona, western Texas, and northern Mexico. The wood is heavy, hard, close grained, brown in color.

17. *Quercus rubra* L. Red Oak. A large forest tree 70° to 80° in height and with trunk diameter of 2° to 4°. Trees growing in dense forests are tall and straight with a rather narrow crown of few branches. Bark on young trees smooth and light gray, on old trunks regularly and coarsely fissured, 1'-1½' thick, dark brown with a tinge of red. Leaves obovate or oblong 5'-9' long, 4'-6' broad with 5-11 coarse toothed bristle tipped lobes, usually divided about half way to the midrib, lobes wedge-shaped tapering from the base, and mostly with three teeth at the apex. Thin and firm, hairy at first becoming smooth, dark green and dull above, pale yellow green below with occasional small tufts of rusty hairs in the axils of the veins. Acorns solitary or in pairs maturing in the autumn of the second season. Sessile or borne on short stalks. The cup is shallow, saucer-shaped enclosing only the base of the nut. Scales closely appressed, bright red brown somewhat glossy. Nut ovoid, flat at the base ¾'-1' long rounded at the apex, gray or reddish brown, more or less pubescent.

Nova Scotia and Minnesota, south to Florida and Texas.

The wood is heavy, hard, close-grained, strong light reddish brown. It is used for building material, finishing, car and wagon stock. The red oak is also a very desirable tree for ornamental planting. It thrives best in a moist rich soil where it grows rapidly.

18. *Quercus Schneckii* Britton. Schneck's Oak. A large forest tree 150° high and 4°-6° in diameter, but usually smaller. The trunk is tall and straight with a buttressed base. The lower branches are drooping while the upper are widespreading and form a wide, rounded open crown. Bark on young branches smooth and gray, on old trunks dark brown with a tinge of red, fissured, the ridges flat, furrows shallow. The leaves are ovate to obovate 3'-7' long, wedge-shaped or truncate at base with 5-9 lobes which extend more than half way to the midrib; the lobes are wedge-shaped or oblong usually

toothed, the teeth ending in bristles; thin, bright green, shiny and smooth above, paler and smooth with reddish brown hairs in the axils of veins below, petioles $\frac{1}{2}$ ' long. The acorns are borne solitary or in pairs sessile or on very short stalks. Nut ovoid $\frac{3}{4}$ ' long, reddish brown sometimes striped with



Fig. 15. *Quercus Schneekii*.

darker lines, somewhat hairy, enclosed for about one-third its length in the saucer-shaped cup which is rounded or nearly flat.

Iowa, Illinois, and Indiana south to Florida and Texas.

Uses similar to *Quercus rubra*.

19. **Quercus velutina** Lamark. Black Oak. A large forest tree 150° high and 3°-4° in diameter, but usually smaller, 70°-80° high. The branches are slender, ascending, and with stout branchlets form a widespreading, rounded crown. Bark on trunks thick, deeply fissured, not scaly, dark brown or



Fig. 16. *Quercus velutina*.

almost black, inner bark deep orange. Leaves obovate to oblong, quite variable in size, and from 5'-7' long, 5-9, most generally 7-lobed, the openings between the lobes are wide and rounded, sometimes extending almost to the midrib; lobes broad, oblong to triangular, bristle tipped, usually wedge-

shaped at base, thin and firm at maturity, smooth glossy, bright green above, paler or yellow green and smooth below or with hairs in the axils of the veins. The acorn sessile or nearly so, solitary, or in pairs. Nut subglobose, ovoid or oblong, $\frac{1}{2}'$ to $\frac{3}{4}'$ long, somewhat hairy, especially at the summit, enclosed for about one-half its length in the deeply cup-shaped cup; kernel yellow, bitter. The scales of the cup are coarse, loose above the middle, thin sharp pointed forming a fringed border to the rim.

Maine to western Ontario, south to Florida and Texas. It occurs in east Texas and in rocky ravines and mountains near the mouth of the Pecos.

The wood is coarse grained, strong, light reddish brown. The wood is not usually distinguished from the red oak commercially, but it is inferior in quality. Its uses are similar to *Q. rubra*.

20. *Quercus Texana* Buckley. Texan Oak. Red Oak. Spotted Oak. Spanish Oak. A small tree, with spreading branches forming a rounded crown. The bark is light brown, somewhat scaly on older portions, thin and smooth on young branches. Leaves oblong to obovate, $2'-4'$ in length, with 3-7 triangular to ovate lobes, the terminal lobe much larger than the others; lobes sometimes toothed, bristle tipped; deep green, smooth, shining above, paler, yellowish below, with prominent red venation. Acorns sessile or on very short stalks; nut ovoid-oblong or oblong, light brown, enclosed for about one-third its length in the hemispheric cup; scales of the cup ovate, blunt, forming a fringe around the rim of the cup.

In dry rocky soils of southern and western Texas.

The wood is close grained and hard. It is used for fuel.

21. *Quercus digitata* Sudw. Spanish Oak. A forest tree 70° - 80° high with trunk diameter of 2° - 3° . The branches are stout, spreading, and form a loose open crown. The bark is $\frac{3}{4}'$ - $1'$ thick, dark brown, fissured, the furrows usually narrow, sometimes wide, ridges rather broad, broken into short plates; young shoots at first hairy greenish red or gray brown, becoming smooth and dark gray brown. Leaves oblong or

obovate, quite variable in outline, 3'-9' long; somewhat curved, wedge-shaped, rounded or truncate at the base, 3-11, usually 5-9 lobed; the number of lobes more variable than in any other of the oaks; the middle lobe is generally longer than



Fig. 17. *Quercus digitata*.

any of the others, but the terminal lobe is frequently much elongated and scythe-shaped. Acorns borne sessile or almost so; nut subglobose, $\frac{3}{8}$ ' long, more or less hairy, light brown, enclosed for about one-half its length in the cup-shaped cup; scales of cup thin, oblong, reddish and hairy.

New Jersey to Missouri, Florida and Texas. In Texas it extends to the valley of the Brazos.

Its uses are similar to *Quercus rubra*. The tree is planted for ornament and shade, for which it is well adapted.

22. *Quercus Marylandica* Muenchaussen. Black Jack Oak. Black Jack. A forest tree 40°-50° high with trunk diameter of 18', but usually much smaller. The branches are short, stout, often contorted and form a compact rounded crown. Bark 1'-1½' thick, black, very rough on mature trunks. Leaves broadly obovate 6'-7' long, 3-5 lobed, narrowly rounded or



Fig. 18. *Quercus Marylandica*.

heart-shaped at base, thick almost leathery, deep green and smooth above, paler pubescent and with prominent venation below; the notches between the lobes quite variable, frequently only undulate lobed; lobes bristle tipped. Acorns borne solitary or in pairs sessile or nearly so; nut subglobose or ovoid $\frac{3}{4}$ ' long, hairy, light yellow brown sometimes striate; enclosed for about two-thirds its length in the top-shaped cup; scales of cup blunt, light or reddish brown, hairy, rather loose particularly near the top.

New York to Pennsylvania, Indiana and Nebraska, south to Florida and Texas.

The wood is of little value except for fuel.

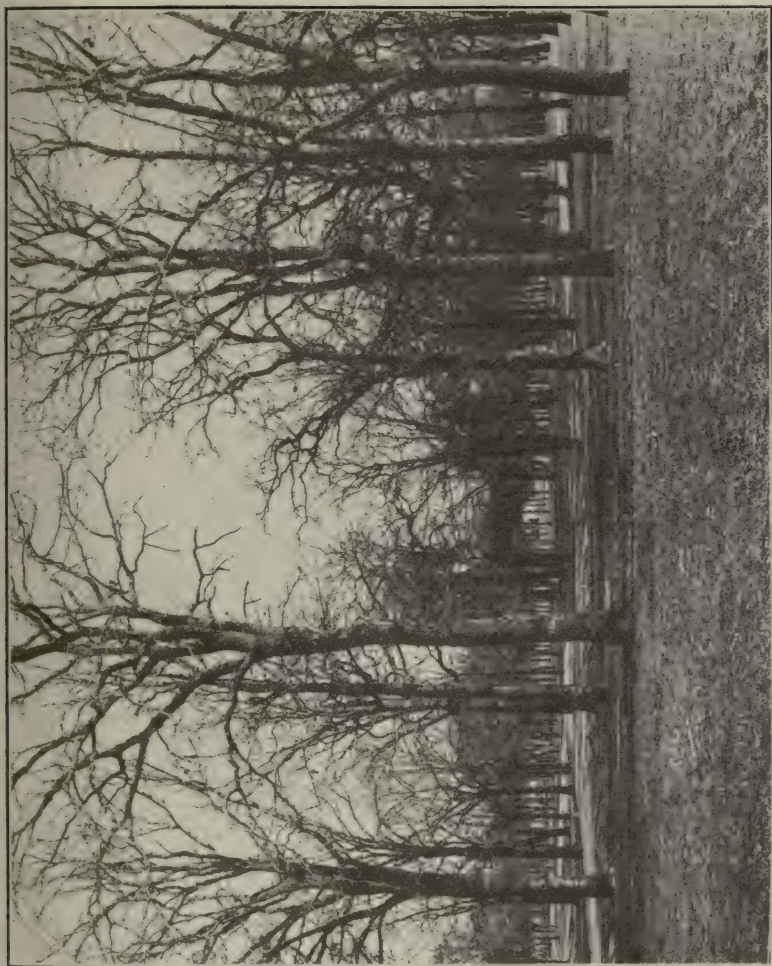


Fig. 19. Post oak trees in winter.

23. *Quercus nigra* L. Water Oak. A round topped forest tree sometimes 80° high with slender branches, smooth, light brown bark and reddish twigs. Leaves oblong some of them



Fig. 20. *Quercus nigra*.

three or more lobed toward the apex and linear-obovate, $2\frac{1}{2}$ '-6' long, $1\frac{1}{2}$ '- $2\frac{1}{2}$ ' wide, dull green above, paler below, petioles short. Fruit solitary or in pairs, sessile or short stalked; acorn ovoid $1\frac{1}{2}$ '- $2\frac{2}{3}$ ' long and almost as wide, enclosed at the base in a thin saucer-shaped cup, often striate.

Delaware, Florida, west to the Colorado River, Texas.

The wood is heavy, hard, close grained and strong. It is used for fuel.

24. *Quercus Phellos* L. Willow Oak. A forest tree 70°-80° high, with trunk diameter of 2°-4°. The branches are small and form a rather narrow, open rounded crown. The bark is thin, $\frac{1}{2}$ '- $\frac{3}{4}$ ' thick, light reddish brown, smooth on young branches, shallowly fissured on old trunks. Leaves



Fig. 21. *Quercus Phellos*.

linear oblong, ovate lanceolate or sometimes lanceolate-obovate, acute at both ends often falcate, entire or undulate margin, 2 $\frac{1}{2}$ '-5' long, $\frac{1}{2}$ '-1' wide, borne on short petioles, thick, smooth and shining above, paler and somewhat hairy beneath. Acorns borne usually solitary, sessile or very short-stalked; nut subglobose or hemispherical, covered with pale pubescence,

inclosed only at the base in the shallow saucer-shaped cup; scales of cup close, thin, hairy dark reddish brown.

New York to Florida, west to Kentucky, Missouri and Texas. It prefers wet sandy soil and is found principally along swamps, but sometimes occurs on highland. In Texas it extends to the Sabine River.

The tree has been planted extensively for ornament. It is hardy as far north as southern New England. The wood is used in somewhat the same way as *Quercus rubra*.



Fig. 22. *Quercus cinerea*.

25. *Quercus cinerea* Michaux. Upland Willow Oak. Blue Jack Oak. A tree usually 15°-20° high with trunk diameter of 5'-6', but sometimes larger, 50°-70° high. The branches are stout and stiff, forming a rather narrow irregular crown. Some



Fig. 23. A mixed forest of pine and upland oak (Bray Bulletin 47 Bureau of Forestry, U. S. Dept. Agr.).



Fig. 24. Forest of *Quercus Michauxii* or the Trinity River (Bray Bulletin 47 Bureau of Forestry, U. S. Dept. Agr.).

trees are broad and rounded. The bark is $\frac{3}{4}$ '- $1\frac{1}{2}$ ' thick, divided into small angular plates, covered with black scales. Leaves oblong-lanceolate to oblong-obovate 2'-5' long, $\frac{1}{2}$ '- $1\frac{1}{2}$ ' wide, entire or with undulate margins, sometimes slightly lobed near the apex, blue green above, pale hairy beneath, slightly bristle tipped. Acorns borne sessile, produced in great numbers; nut oblong to subglobose, $\frac{1}{2}$ ' long, light brown often striate, hoary pubescent at the apex; cup saucer-shaped enclosing the nut only at the base or for about one-half its length.

North Carolina to Florida and west to Texas. It occurs principally on sandy uplands, mostly near the coast. In Texas it extends to the valley of the Brazos.

The wood is hard, close grained, strong. It is used principally for fuel. The trees of our area are small.

MORACEAE. The Mulberry Family.

Trees with milky sap; leaves simple, alternate, two ranked, serrate entire or variously lobed, 3-5 veined at the base; flowers borne in ament-like spikes or heads on the outside of a receptacle or on the inside of a closed receptacle; fruit compound, drupaceous.

1. Flowers on the outside of the receptacle.

- a. Flowers all in spike like catkins, fruit an elongated edible berry somewhat resembling the blackberry..... 1. *Morus*.
- b. Pistillate flowers in heads, fruit globose, not edible.
 - (1) Branches armed with thorns, leaves entire 2. *Toxylon*.
 - (2) Branches unarmed, leaves serrate or lobed 3. *Broussonetia*.

2. Flowers borne inside a hollow receptacle..... 4. *Ficus*.

1. **MORUS.** The Mulberries.

Trees with edible fleshy fruit, milky juice; flowers monocious or dioecious; leaves often deeply irregularly lobed.

- Leaves rough above, pubescent beneath, fruit red
or purplish..... 1. *M. rubra*.
Leaves smooth on both sides or nearly so.
Leaves large 2-½'-6' long..... 2. *M. alba*.
Leaves small 1-½' long, ¾' wide..... 3. *M. microphylla*.

1. ***Morus rubra* L.** Red Mulberry. A tree 60°-70° high, and 3°-4° in diameter. The trunk is generally short and the branches stout, forming a dense rounded broad crown. The bark is dark brown somewhat tinged with red, ½'-¾' thick, fissured into long thin plates. Leaves broadly ovate or ovate-



Fig. 25. *Morus rubra*.

orbicular, contracted at the apex into a long point, heart-shaped or rounded at base, coarsely serrate, frequently 2-7, mostly 3, lobed, smooth above, hairy beneath, thin, dark bluish green, turning yellow before falling from the tree. The flowers appear with the opening of the leaves; pistillate aments about half as long as the staminate. Fruit cylindric about ½'-1½' long, dark purple or almost black when mature.

Massachusetts to Ontario; Michigan and Nebraska, south to Florida and Texas. Occurs most frequently in moist situations. In Texas it extends to the valley of the Colorado River.

The wood is light, soft, but tough, takes a high polish, durable in contact with the soil. It has been used for cross ties

and posts, but the supply is not sufficient to be of much economic importance. The tree is hardy and easily transplanted. It has been extensively planted for ornament.

2. **Morus alba** L. White Mulberry. A tree reaching a height of 40°-60° with diameter of 2°-3°, but usually smaller.



Fig. 26. *Morus alba*.

The trunk is short and low branched, forming a round topped crown. Bark thin, light gray, furrowed into rough ridges. Leaves thin, firm, ovate or ovate oval, sharp-pointed at the apex, heart-shaped or rounded at the base, serrate, sometimes lobed, smooth, light green above, paler and hairy along the veins below. The staminate aments are slender, drooping,

the pistillate, ovate, shorter. The fruit is white, or pinkish, sweet, edible, insipid.

Introduced from Europe, where the leaves are used for feeding the silk worm. It has been extensively planted for ornament, and thrives best in rich moist soil. It grows well, however, on the dry prairies.

3. **Morus microphylla** Buckley. Texan Mulberry. A small tree or shrub sometimes 30° high and 12'-14' in diameter with slender branches. The bark is smooth, thin, $\frac{1}{2}'$ thick or less, light gray, fissured with surface scales. Leaves ovate,

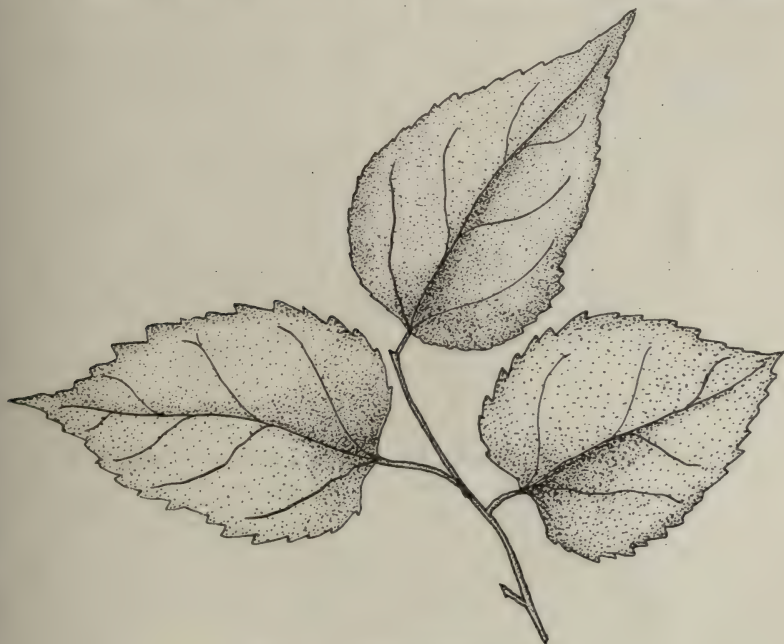


Fig. 27. *Morus microphylla*.

rounded or sharp-pointed at the apex, serrate, heart-shaped at base, occasionally lobed, thin and firm, dark green, roughened above, paler and hairy along the midribs below, $1\frac{1}{2}'$ long, $\frac{3}{4}'$ wide. Flowers are borne in short spikes. Fruit dark purple to black with light brown, thick walled seeds, edible.

Texas to Arizona and Mexico. In Texas it occurs principally near the Mexican border.

2. TOXYLON Raf. Osage Orange.

Small trees with alternate, simple, entire leaves, milky juice and axillary thorns.

1. Toxylon pomiferum Raf. Osage Orange. A small thorny tree which may reach a height of 50°-60° with trunk diameter of 2°-3°, but usually smaller. Bark 2/3'-1' thick with broad rounded ridges, somewhat shreddy, brown. The spines are about 3/4' long, and produce painful wounds. The leaves are ovate lanceolate, entire, long pointed, smooth, and glossy green above, 3'-5' long, 2'-3' wide. The staminate flowers are borne in elongated catkins, the pistillate in rounded heads. The fruit is yellowish green, resembling an orange, outer coat rough, about 4' in diameter.

Missouri and Kansas, south to Texas.

The wood is heavy, hard, strong and durable in contact with the soil. It is extensively used for fence posts. The tree has been extensively planted in the prairie regions for hedge fences. When well pruned and taken care of, it makes a thick almost impenetrable barrier for all kinds of animals. Now largely superceded by wire fences. Not so well adapted for ornamental hedges as many other shrubs.

3. BROUSSONETIA Ventenat. Paper Mulberry.

Broussonetia papyrifera Ventenat. A small tree with greenish gray bark, milky juice and stout hairy twigs. Leaves thin, 3-5 lobed or sometimes with only one lateral lobe, rough above, hairy below, borne on long stalks. Flowers diecious, the pistillate in dense round heads on one tree, the staminate in catkins on another. Fruit a globular aggregate of small red drupelets 1/2'-1' in diameter.

Native of Asia, introduced and growing spontaneously in this country.

The fibrous inner bark is used in the manufacture of paper.

4. FICUS (Tournefort) L. The Figs.

Trees, shrubs or woody climbers with milky sap; thick, leathery mostly alternate lobed leaves; flowers borne in a receptacle, usually dioecious.

Ficus carica L. Common Fig. A shrub or round topped, small tree with short trunk, close, smooth, reddish or gray bark and stout, pithy twigs. Leaves large, thick, firm, leath-

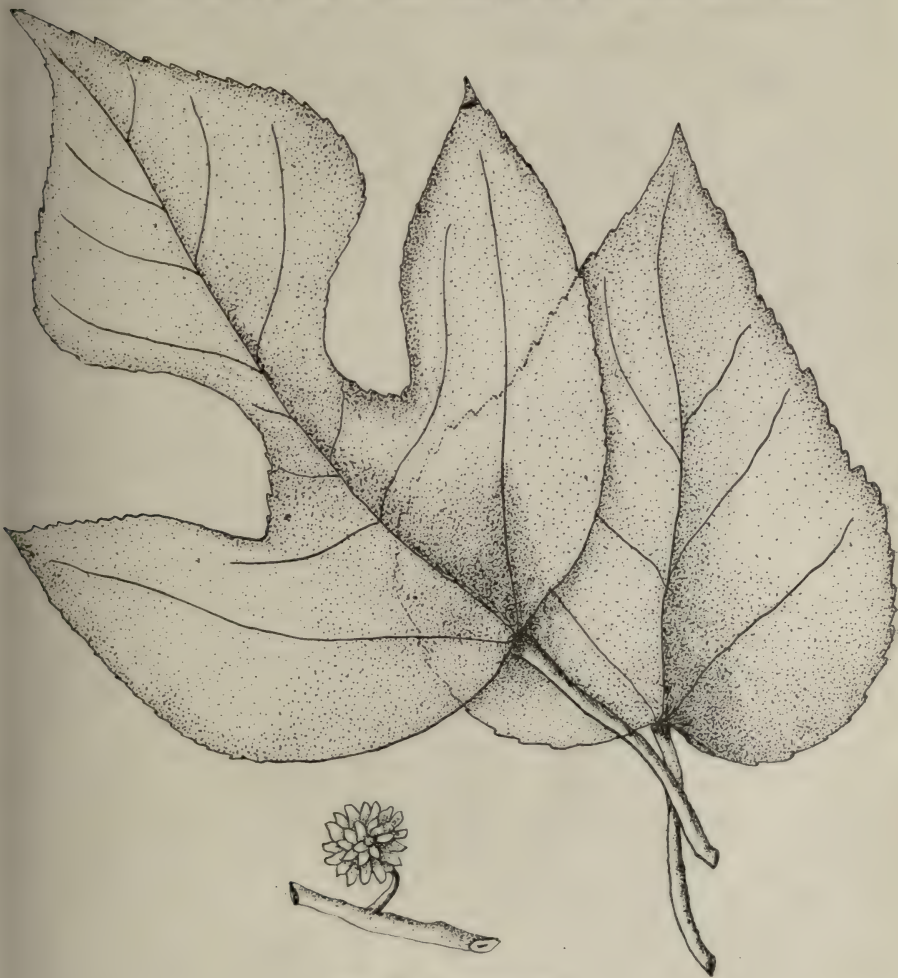


Fig. 28. Broussonetia.

ery, suborbicular or oval, deeply 5-7 lobed, rough and hairy above, pale and hairy beneath. Flowers dioecious, the staminate usually absent in the cultivated form. Fruit pear-shaped, with soft, sweet edible flesh.

A native of the Mediterranean region, extensively planted in our area for fruit and ornament.

ULMACEAE Mirbel. The Elm Family.

Trees with watery juice; leaves alternate, simple, serrate, pinnately veined; flowers small and without the corolla; fruit

a samara, drupe or small nut.

Leaves with one primary vein at base, lateral veins parallel.

Fruit a samara winged all the way around.... 1. *Ulmus*.

Fruit a small nut with soft tubercles..... 2. *Planera*.

Leaves 3-veined at the base, fruit a fleshy, juicy drupe 3. *Celtis*.

1. ULMUS L. The Elms.

Trees with deeply furrowed bark; leaves simple, alternate two ranked, doubly serrate, taper pointed, unequal at base, lateral veins prominent and parallel; flowers small clustered appearing in the spring before the leaves in all except one species; fruit a samara surrounded by a wide membranous wing.

Flowers opening in the autumn, borne in the axils of the leaves of the season..... 1. *U. crassifolia*.

Flowers opening in the spring before the leaves.

Branches corky winged..... 2. *U. alata*.

Branches not corky winged.

Leaves smooth or somewhat roughened above, inner bark not mucilaginous... 3. *U. Americana*.

Leaves very rough above inner bark, mucilaginous 4. *U. fulva*.

1. *Ulmus crassifolia* Nuttall. Cedar Elm. A forest tree sometimes reaching a height of 80° with trunk diameter of 2°-3°, but usually smaller. The branches are usually wide-spread and droop, forming a flat topped wide crown. Leaves oblong-oval with rounded apex and unequal base, finely doubly serrate, very rough and dark green above with soft pubescence below, 1'-2' long, ½'-1' wide. The flowers appear in the autumn in the axils of the season's leaves. They are borne in clusters of three to five. The fruit ripens in September or sometimes in November, depending upon the time of flowering. The bark is light brown, tinged with red,

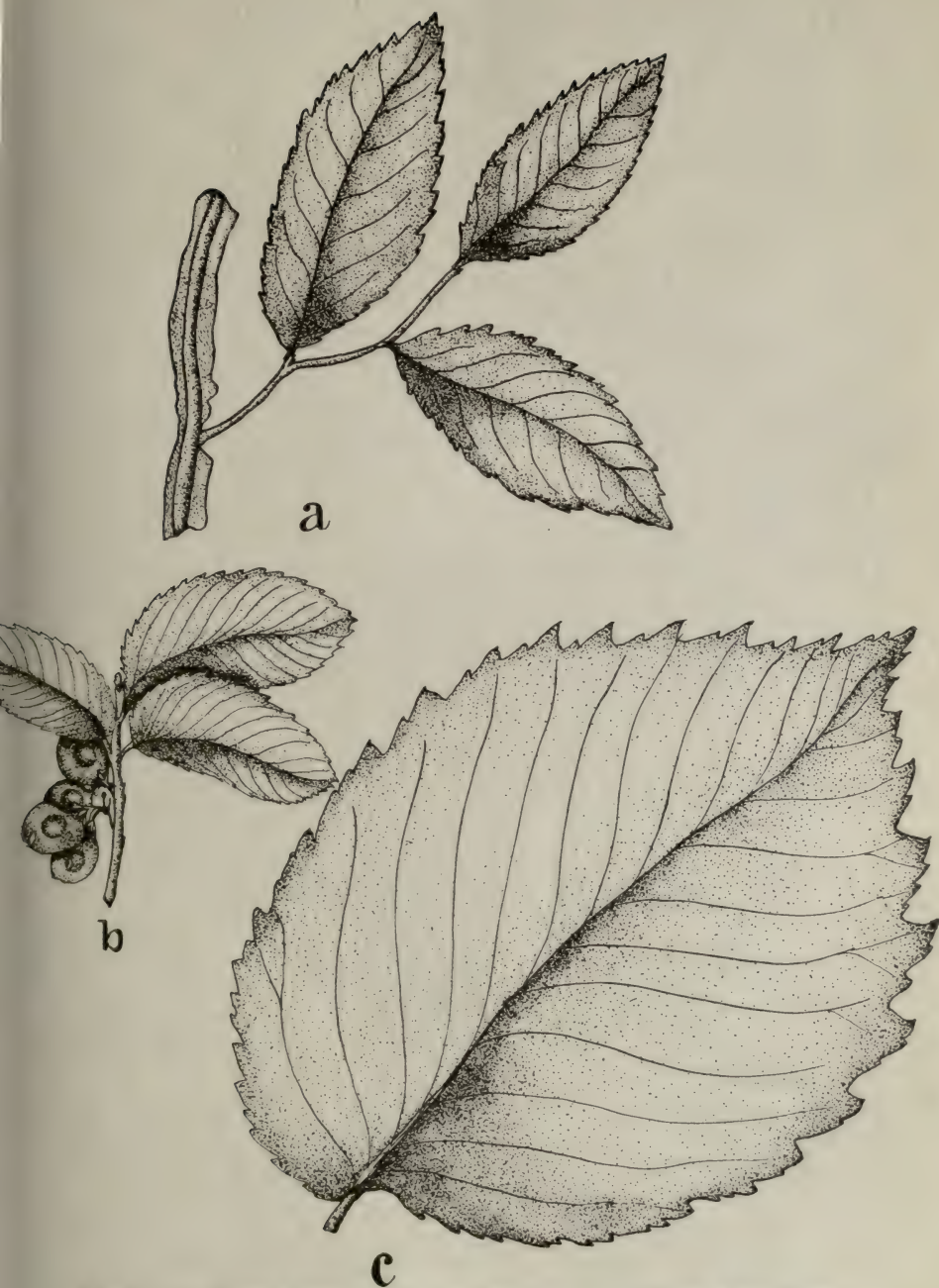


Fig. 29. a. *Ulmus alata*. b. *Ulmus crassifolia*. c. *Ulmus Americana*.

about one inch thick, deeply fissured, the furrows interrupted, the ridges broad and flat.

Southern Arkansas to Mississippi, Texas, and Mexico. It is the commonest elm tree of our area, and reaches its maximum size along the Guadalupe and Trinity rivers.

The wood is reddish brown, heavy, hard, strong and brittle. It is used for hubs, furniture, and fencing. The tree is frequently planted for ornament and shade.

2. *Ulmus alata* Michx. Winged Elm. A forest tree 40°-50° high and with a trunk diameter of 2° or less. The branches are short, stout, ascending and form a rather open crown. Bark thin, with shallow fissures, light reddish brown with flat ridges. The young twigs develop corky wings which are persistent. Leaves ovate-oblong to oblong-lanceolate, somewhat scythe-shaped, rather sharp-pointed at the apex, 1½'-3' long, wedge-shaped or rounded at the base, doubly serrate, the teeth curved inward, thick and firm almost smooth above, pubescent below. The flowers are borne in the early spring before the leaves unfold. The fruit is ripe at about the time the leaves appear.

Virginia, Indiana, Illinois and Kansas, south to Florida and west to Texas. It thrives best in dry soil. In Texas it extends to the valley of the Trinity River.

The wood is heavy and hard, but not strong, close grained. It is used for hubs, handles for implements and fuel. The tree is extensively planted for shade and ornament throughout its range.

3. *Ulmus Americana*. White Elm. American Elm. A large forest tree sometimes 100°-120° feet high and 6°-11° in diameter. The branches are upright, gradually spreading to form a wide spread rounded crown of great beauty. Bark ashy gray, 1'-1½' thick, deeply fissured, with rather broad ridges. Leaves oval to obovate-oblong, 2'-5' long, dark green, and somewhat rough above, paler and smooth or pubescent below, abruptly pointed at the apex, unequal at base, sharply doubly serrate. The flowers are clustered, borne on slender stalks, opening in early spring before the leaves. The fruit ripens with the unfolding of the leaves.

Quebec to Florida, west to Nebraska and Texas. The trees

of our area are not so large and ornamental as the trees growing in the northeastern states.

The wood is hard, tough, flexible, and difficult to split. It is used for agricultural implements, hubs, crates, staves, and heading. It is also used extensively in furniture making, as it takes stains very well. The tree has been a great favorite for shade tree planting. It grows rapidly. The American elm is one of our most beautiful native trees, and its planting should be encouraged.

4. *Ulmus fulva* Michaux. Slippery Elm. Red Elm. A forest tree 60°-70° high with trunk diameter sometimes reaching 2°, usually smaller. The branches spread to form a broad open flat-topped crown. Bark deeply fissured, reddish brown, the inner layer fragrant and mucilaginous. Leaves ovate-oblong, 4'-6' long, coarsely doubly serrate, rounded on one side at base, oblique on the other, thick dark green, very rough above, more or less pubescent beneath. The flowers appear before the leaves in the early spring and the fruit ripens when the leaves are about one-half their mature size.

Quebec to Florida, west to North Dakota, Nebraska and Texas. It extends to the valley of the San Antonio River.

The wood is hard, strong, light, durable when exposed in the soil. It is used for cross ties, fence posts and otherwise as *Ulmus Americana*.

2. *PLANERA* Gmelin. Planer Tree.

***Planer aquatica* Gmelin.** A small tree 30°-40° high and 20' in diameter with low broad crown and slender branches. Bark thin, about $\frac{1}{4}$ ', light brown, falling away in large scales. Leaves ovate-oblong, rounded or unequally wedge-shaped at base, pointed or rounded at the apex, toothed, 2'-2 $\frac{1}{2}$ ' long, $\frac{3}{4}$ '-1' wide, dark green above, paler below. Flowers of two kinds, the stamen bearing or staminate are borne on wood of the previous year, the pistil bearing or pistillate in the axils of leaves of the current season. The fruit is a nut-like structure covered with elongated projections, ripening in the spring. The tree resembles the elms, but may be readily distinguished by the fruit.

North Carolina to Florida and west to Texas. It extends into Texas as far as the Trinity River.

The wood is of no economic value.

3. **CELTIS** (Tournefort) L. The Hackberries.

Trees or shrubs with simple alternate leaves, smooth, thin or warty bark, and scaly buds. The leaves are 3 rarely 4-5 veined at the base, entire or toothed; staminate flowers borne in clusters, pistillate solitary or few together in axils of the leaves; fruit an ovoid or globose drupe with thin sweet pulp and wrinkled bony stone. The drupe hangs on the tree until early spring. The hackberry is our commonest shade tree.

1. Leaves sharply and coarsely serrate..... 1. *C. occidentalis*.
2. Leaves entire or with only a few teeth.
 - a. Leaves densely gray tomentulose beneath, few toothed, somewhat heart-shaped at base..... 2. *C. Helleri*.
 - b. Leaves smooth or nearly so beneath.
 - (1) Leaves thick, strongly reticulate veined with a few teeth..... 3. *C. reticulata*.
 - (2) Leaves thin, entire, slightly curved lanceolate to ovate lanceolate..... 4. *C. Mississippensis*.

1. **Celtis occidentalis** L. Hackberry. White Hackberry. Usually a small tree 30°-40° high and 1°-2° in diameter, but occasionally much larger. The trunk branches a few feet from the ground into a few large limbs. The small branches are horizontal, forming a broad rounded crown. Bark on young twig green, somewhat hairy, becoming reddish brown; on old trunks thick, light brown or silver gray, with short ridges or warty excrescences. Leaves ovate, 2¼'-7' long, usually long taper pointed, slightly heart-shaped or unequal at base, usually sharply toothed occasionally entire margined, thin, smooth or nearly so above, hairy beneath. The flowers appear during April and May, they are small and inconspicuous. The fruit is a globular drupe ¼' long, dark purple. It is sweet and edible. The tree is known in some localities as sugar berry.

St. Lawrence Valley to the Gulf States, and west to Texas and Manitoba. It occurs only in the eastern part of Texas.

The wood is yellowish white, heavy, but not strong. It resembles the ash somewhat and is used for the same purposes. The tree is also planted for shade and ornament.

2. **Celtis Helleri** Small. Heller's Hackberry. A small tree with maximum height of 30°-40° and trunk diameter of



Fig. 30. *Celtis reticulata*.

2°-3°. The branches are widespread, forming a rounded crown. Bark on mature trunks is characterized by the numerous corky warts. The young twigs are slender and hairy, becoming smooth and brown with age. Leaves firm, ovate to

oblong or sometimes oblong-lanceolate, $1\frac{1}{2}'$ - $4'$ long, pointed or blunt at the apex, heart-shaped at base, dark green and rough above, hairy below, with rather prominent netted veining, toothed above the middle. Fruit globular, light, lustrous brown, borne on short curved stalks. Seeds globose with four prominent ribs.

Dry soil of southern Texas.

The wood is similar to *Celtis Mississippiensis*, from which it is not generally distinguished. The tree is used for street and ornamental planting.

3. ***Celtis reticulata*** Torrey. Thick Leaved Hackberry. A small bushy tree 40° - 50° high with rounded crown. Bark bluish gray and covered with numerous corky warts on the older parts of the stem. Leaves thick and very strongly netted veined, entire or toothed above the middle, dark green and smooth or sometimes rough above, paler and somewhat hairy beneath, with prominent reticulate veining. Fruit globular, red, $\frac{1}{4}'$ to $\frac{1}{2}'$ long, borne on stalks which are usually longer than the subtending leaf petiole.

Kansas to Texas, Colorado, Nevada, Arizona, and Lower California. It is widely distributed in Texas.

Uses similar to *Celtis Mississippiensis*.

4. ***Celtis Mississippiensis*** Bosc. Mississippi Hackberry. A tree 60° - 80° high and 2° - 3° in diameter. The branches are somewhat pendulous and form a broad rounded crown. Bark light gray with corky warts, $1\frac{1}{2}'$ - $2\frac{2}{3}'$ thick. Leaves broadly ovate to ovate-lanceolate, long pointed somewhat curved, unequal at base, entire or with never more than one or two teeth, firm dark green and smooth above, paler below, $3'$ - $4'$ long, $\frac{3}{4}'$ - $3'$ wide. Fruit ovoid-globose $\frac{1}{8}'$ - $\frac{1}{4}'$ long, bright orange red, borne on a stalk which is somewhat elongated. The tree differs from other hackberries particularly in the size of the fruit and in the entire margined leaf. It is the commonest of our hackberry trees.

Indiana to Florida, and west to Missouri and Texas.

Used for fuel, fencing, and to some extent for flooring. The commonest street shade tree in central Texas.



Fig. 31. *Celtis Mississippiensis*.

ALTINGIAECEAE Hayne. Sweet Gum Family.

Liquidambar.

Liquidambar styraciflua L. Sweet Gum. A tree 80°-140° high with straight erect trunk 4°-5° in diameter. The branches

are slender and form a rather narrow crown. Bark deeply furrowed, gray to brown, $\frac{3}{4}$ '-1 $\frac{1}{2}$ ' thick. The young branches are frequently winged with cork. A resinous sap which issues from wounds is popular among children as "gum." Leaves alternate, almost round in outline, about 5' wide, cleft into 4-7 wedge-shaped, serrate lobes, firm, bright green, and shining above, paler below, aromatic when bruised, smooth on both sides or nearly so, turning red in the autumn before they fall. Flowers appear when the leaves are about half the adult size. The staminate flowers are borne in slender racemes, the pistillate in a dense globular head. Fruit a globular, spiny, cone-like aggregate, 1 $\frac{1}{4}$ '-1 $\frac{1}{2}$ ' in diameter, which frequently persists on the tree throughout the winter.

Connecticut west to Missouri, south to Florida and Texas. In Texas it extends to the valley of the Trinity River, most abundant in heavy bottom soils.

The wood is heavy, close-grained, hard but not strong. It polishes well and can be finished to imitate walnut. However, it warps and shrinks to such an extent that it is but little used for timber. The tree is planted for ornament but is transplanted with some difficulty. Its foliage is beautiful throughout the summer and the autumnal tints add to its value as an ornamental tree. In our area, it is attacked by a fungus parasite which tends to mar the beauty of the foliage in the late summer.

ANONACEAE de Condolle. The Custard Apple Family.

Asimina (L) Dunal. The Pawpaw.

Asimina triloba Dunal. A tall shrub or small tree sometimes reaching a height of 25° or 30° with a trunk diameter of 1°, but usually much smaller, with slender nodding twigs. Bark smooth, somewhat ridged on old trees, about $\frac{1}{8}$ ' thick, gray or brown with lighter blotches except on young twigs, where it is reddish brown. Leaves obovate-lanceolate, wedge-shaped at base, sharp pointed at the apex, 4'-12' long, 4'-6' wide, green above, paler and hairy beneath when young, becoming smooth with age. The leaves give off a rank foetid odor when crushed. The flowers appear before or with the

leaves. The sepals are green, broadly ovate; the six petals are green at first but soon become maroon color. Fruit cylindrical, somewhat curved, about $2\frac{1}{2}$ '-5' long, green becoming yellow, finally brown. The flesh is sweet and edible and the fruit has been recently called the "Hoosier banana."

Southern Ontario, east to Pennsylvania, south to the Gulf States and west to Kansas and Texas. In Texas it extends to the valley of the Sabine River.

The wood is soft, light, and coarse grained. The supply is so small that it has no economic importance for timber. The fruit is edible and the tree is adapted for ornamental planting within its native range. It prefers deep rich moist soil.

MAGNOLIACEAE St. Hilaire. The Magnolia Family.

Trees with alternate simple, entire, large leaves and bitter, aromatic bark. The flowers are large, perfect, solitary, terminal. The fruit is a cone-like aggregate.

Leaf blades thick, leathery, persistent, with brown,

rusty hairs beneath..... *M. foetida*.

Leaf blades membranous, smooth or silky beneath.. *M. Virginiana*.

1. **Magnolia foetida** (L.) Sargent. Bull Bay. Laurel. A large cone-shaped tree 60°-80° high and 4°-5° in diameter, with short branches, and rough, light brown, scaly bark $\frac{1}{2}$ '- $\frac{3}{4}$ ' thick. Leaves evergreen, firm, leathery, bright glossy green above, duller and covered beneath with rusty hairs, 5'-8' long, 2'-3' wide with prominent ribs and veins. Fruit ovate or oval 3'-4' long, $1\frac{1}{2}$ '- $2\frac{1}{2}$ ' wide, flattened somewhat and covered with hair.

In river swamps and near ponds. North Carolina, south to Florida and westward to Arkansas and Texas. In Texas it extends to the Brazos valley.

The wood is rather hard and used to a very limited extent only for timber. The tree is planted for ornament and is highly prized throughout its range.

2. **Magnolia Virginiana** L. Sweet Bay. White Bay. Swamp Bay. A slender tree reaching a maximum height of 50°-70° with trunk diameter of 2° to $3\frac{1}{2}$ °, but usually small-

er, the base of the trunk is frequently swollen. Bark thin and gray on mature trunks, pale gray or almost white on younger branches. The twigs are covered with fine hairs. Leaves oblong to elliptic, firm, evergreen, green and shining above, pale and with fine silky hairs below, 4'-6' long, $\frac{1}{2}$ '-2 $\frac{1}{2}$ ' wide, with prominent veins and midrib. Flowers globular, white and fragrant. Fruit oval, smooth, dark red, 2' long, $\frac{1}{2}$ ' wide, with flattened seeds.

Massachusetts, Pennsylvania, south to Florida and west to Arkansas and Texas. In Texas it extends to the Trinity Valley.

The wood is rather light and is not extensively used for timber. The tree is planted for ornament throughout its range and is well adapted for this purpose.

PLATANACEAE Lindley. The Plane Tree Family.

Platanus. The Plane Tree.

Platanus occidentalis L. Sycamore. Button Wood. A very large tree 140°-170° high with a trunk diameter sometimes reaching 10°-11°. The trunk frequently branches near the ground into several large secondary divisions forming a very wide spread, irregular, open crown. Bark on old trunks is gray to reddish brown with plate-like scales, on younger portions it is grayish green, thin, separating from the tree in large, thin brittle plates which exposes the whitish smooth inner layer, giving the tree a clean "whitewashed" appearance. Leaves broadly ovate, 3-5 lobed, 4'-9' wide, the lobes broad, toothed, thin and firm, bright green above, paler below, hairy when first expanded, becoming smooth with age. Flowers borne in dense globular heads on wooly stalks appearing with the leaves. Fruit a globular head $\frac{1}{2}$ '-1 $\frac{1}{2}$ ' in diameter which bears numerous seeds, and persists on the tree until the following spring. The seeds drop out throughout the early winter.

Southern Ontario, Maine, south to the Gulf States and west to Nebraska and Texas. In Texas it extends to the valley of the Devils River. It grows principally along streams and in

rich lowlands, but is extensively planted in Texas as an ornamental shade tree on dry uplands, where it thrives very well.

The wood is heavy, hard, close-grained, but weak, takes a high polish and is used to some extent for interior finishing. The tree is not regarded in the northern states as desirable for ornamental planting as the leaves are attacked by a fungus which causes them to fall prematurely. In our area, however, the defoliation does not appear to be so severe from this cause and it has been extensively used as a street shade tree. It is undoubtedly superior to some trees which are more abundantly grown.

MALACEAE Small. The Apple Family.

Trees with simple alternate leaves, regular perfect flowers, and more or less fleshy, pomaceous fruits.

Mature fruit green in color with mature carpels

papery 1. *Malus*.

Mature fruit red, orange, blue, black, yellow with

mature carpels bony..... 2. *Crataegus*.

MALUS. The Apples.

Malus Scoulerii (Bailey) Britton. Crab Apple. A small, upright, stout tree reaching a height of 15°-25° and a trunk diameter of 6'-8', with rather stiff and dense rounded crown. Bark reddish brown, fissured, and scaly, rather thin. Leaves ovate, elliptic or obovate, blunt at the apex with rounded narrow base, irregularly toothed or sometimes lobed, very wooly at first but becoming smooth above, remaining hairy beneath. Flowers rather large, about 1½'-2' in diameter when fully expanded, rose pink, in dense flat topped clusters. Fruit flattened, globose about 1¼' long and 1½' in diameter, greenish yellow when mature, the flesh is firm and is acid to the taste.

Minnesota southward to Texas. It occurs but sparingly in the woods of east Texas.

The tree is valuable for ornamental planting.

CRATAEGUS. The Thorn Trees. Hawthorn.

Small trees or shrubs, usually spiny; leaves simple, alternate, toothed, notched or lobed; flowers mostly white; fruit fleshy,

variously colored. This genus comprises more species than any other, some 600 having already been described.

1. Leaves 6-7 lobed, the margins of the lobes sharply serrate..... 1. *C. Apiifolia*.
2. Leaves variously notched, toothed or serrate, sometimes 3 lobed at the apex.
 - a. Leaves broadest above the middle.
 - (1) Leaves entire at base, serrate above the middle, some of them 3 lobed at the apex; fruit scarlet..... 2. *C. spathulata*.
 - (2) Leaves entire at base, serrate toward the apex; fruit green tinged with red.. 3. *C. edita*.
 - (3) Leaves entire at base, serrate above the middle, not lobed; fruit blue or blue black 4. *C. brachycantha*.
 - (4) Leaves oval to obovate; fruit longer than broad, bright canary yellow, $1\frac{1}{3}$ '- $\frac{1}{2}$ ' long..... 5. *C. Brazoria*.
 - (5) Leaves elliptical toothed or serrate above the middle; fruit bright red dotted with pale spots, ripening in May 6. *C. aestivales*.
 - (6) Leaves ovate to oblong ovate, sometimes 3-lobed toward the apex; fruit scarlet or orange, ripening in the autumn, $\frac{1}{8}$ '- $\frac{1}{4}$ ' in diameter..... 7. *C. viridis*.
 - (7) Leaves oblong ovate to semiorbicular, serrate above the middle; fruit dull orange, about $\frac{1}{4}$ ' in diameter..... 8. *C. glabriscula*.
 - b. Leaves broadest at the base..... 9. *C. Texana*.

1. ***Crataegus apiifolia*** Michx. Parsley Haw. A small tree sometimes 20° high with a trunk diameter which may reach 6'-8' but is usually smaller. The branches spread at right angles, forming a rather broad irregular crown. Branchlets armed with stout, straight, chestnut-brown spines which are 1'-1 $\frac{1}{2}$ ' long. Bark smooth and rather thin, gray in color. Leaves broadly ovate to orbicular, somewhat heart-shaped at the broad base, 5-7 lobed, the lobes sharply serrate 1'-1 $\frac{1}{2}$ ' long 2/3'-1 $\frac{1}{2}$ ' broad, bright green above, pale below. Flowers $\frac{1}{2}$ ' in diameter borne in 10-12 flowered corymbs, stamens 20 anthers bright rose red. Fruit oblong to oval $\frac{1}{3}$ ' long, scarlet, with 1-3 nutlets, often hanging on the tree until early winter.

Southern Virginia to Florida and west to Arkansas and Texas. In Texas it extends to the Trinity Valley.

2. *Crataegus spathulata* Michx. Small-fruited Thorn. A small tree 18°-25° high and trunk diameter of 8'-10' with upright, spreading branches which form a rather wide, rounded crown. The branchlets are smooth or armed with straight, brown spines 1'-1½' long. Bark gray or brown, smooth or somewhat scaly. Leaves shaped like a spathula, rounded and sometimes 3-lobed at the apex, serrate except at the base, dark



Fig. 32. *Crataegus apiifolia*.

green above, paler below, 1'-2' long, 1'-1½' wide. Flowers ½' in diameter on slender pedicels in many flowered corymbs; calyx lobes triangular, stamens about 20, anthers rose colored. Fruit ripening in autumn, globose to sub-globose ⅛' in diameter, bright scarlet with 3-5 nutlets and thin, dry mealy flesh.

Virginia to Florida and west to Arkansas and Texas. In Texas it extends to the valley of the Colorado River. It occurs abundantly in the eastern portion of the state.

3. **Crataegus edita** Sargent. A tree sometimes reaching a height of 40° and trunk diameter of 1°, but usually smaller. The branches are stout, horizontal and form a wide, rounded crown. The branchlets are armed with scattred, brown spines which become gray with age. Bark dark, rather thin and scaly. Leave oblong, obovate or oval, $1\frac{1}{2}'$ -2' long, $\frac{1}{2}'$ -1' wide, smooth and dark, lustrous green above, paler and somewhat pubescent along the veins below, serrate above the



Fig. 33. *Crataegus spathulata*.

middle, entire and wedge-shaped at base. Flowers are $\frac{1}{2}'$ - $\frac{2}{3}'$ in diameter, in few flowered corymbs; sepals entire or somewhat serrate, stamens 20, anthers rose red. Fruit ripens in autumn, short oblong $\frac{1}{4}'$ - $\frac{1}{3}'$ long, dull green, tinged with red, with thin, greenish flesh.

In low wet woods and stream borders in the valley of the Sabine River.

4. **Crataegus brachycantha** Sarg. and Engelm. A tree 18°-25° high with trunk diameter of 8'-10', branches upright, spreading to form a rather broad rounded crown; branchlets armed with straight light brown spines 1'-1½' long. Bark dark brown and rather deeply fissured on mature trunks, light brown on younger twigs. Leaves lanceolate-oblong to ovate, serrate above the middle, 1'-2' long ½'-1' wide, dark green above, paler beneath. Flowers in many flowered corymbs. Fruit ripening in August, bright blue, ⅓'-½' in diameter.

Northwestern Louisiana to eastern Texas.

5. **Crataegus Brazoria** Sargent. A small round topped tree 20°-25° high with ascending branches, gray scaly bark, and long gray spines. Leaves oval to obovate, wedge-shaped and entire at base, rounded or pointed at apex, serrate, smooth, lustrous green above, 2'-2½' long, 1¼'-1½' wide, pale beneath with a few hairs. Flowers in many flowered corymbs, the pedicels and calyx hairy. Fruit ripening in autumn, subglobose, bright canary yellow.

In rich woods and bottom lands along the Brazos River.

6. **Crataegus aestivalis**. A medium sized tree 20°-30° high and 12'-18' in diameter with straight or divided trunk, reddish, armed twigs and scaly, reddish brown bark. Leaves elliptical, oblong or obovate, 1½'-2' long, ½'-1' wide, entire at base, notched or toothed above the middle, smooth above, with rusty hairs along the veins and midrib below. Corymb 2-5 flowered. Fruit ripening in May, depressed globose, 1½'-2⅓' in diameter, bright red with pale spots, and thick, juicy flesh.

Florida to Arkansas, Louisiana and eastern Texas.

7. **Crataegus viridis** L. Southern Thorn. A small round topped tree 20°-30° high and 18'-20' in diameter with orange colored bark, gray to reddish brown twigs and slender short spines. Leaves oblong-obovate, pointed or rounded at the apex, wedge-shaped and entire at base, serrate above with glandular teeth or some of them 3-lobed toward the apex, 1'-3' long, ½'-1½' wide, smooth above with hairs in the axils of veins below. Corymbs smooth, many flowered. Fruit ripen-

ing in the autumn, remaining throughout the winter, depressed globose, $\frac{1}{8}$ '- $\frac{1}{4}$ ' in diameter, bright scarlet with thin dry flesh.

Maryland, South Carolina to Florida and west to Missouri and Texas. It extends to the Colorado River.



Fig. 34. *Crataegus viridis*.

8. *Crataegus glabriscula* Sarg. A medium sized tree 20°-25° high with ascending branches, brown, scaly bark and slender, brown spines. Leaves oblong, ovate or somewhat orbicular, pointed or rounded at the apex, $1\frac{1}{2}$ '-2' long, $\frac{3}{4}$ '-1' wide, entire at base, glandular, toothed above the middle, sometimes 2-3 lobed toward the apex. Corymbs few flowered, smooth; pedicels long and slender. Fruit ripening in the autumn and remaining on the tree throughout early win-

ter, obovate to globose, about $\frac{1}{4}$ ' long, dull orange with small dots.

In the bottom lands of the Trinity River.

9. **Crataegus Texana** Buckley. Texas Thorn. A medium sized round topped tree 25° - 30° high with scaly bark, reddish brown twigs and chestnut colored spines. Leaves broadly ovate, pointed at the apex, doubly serrate, frequently 4-5 lobed above the middle, 3'-4' long, $2\frac{1}{2}$ '-3' wide, smooth above, hairy below. Corymbs many flowered, hairy, the flowers large. Fruit ripening in the autumn, pear-shaped when young, becoming short oblong at maturity, $\frac{3}{4}$ '-1' long, bright scarlet, with pale dots. In bottom lands, central and west Texas.

AMYGDOLACEAE Reichenbach. The Plum Family.

Trees or shrubs with alternate simple serrate leaves which are firm or leathery and sometimes persistent until the following season. Flowers regular, perfect, petals 5, sepals 5, stamens numerous. Fruit a one seeded edible drupe.

Drupes fleshy.

Flowers umbellate to corymbose, borne before
the leaves on branchlets of the previous
season 1. *Prunus*.

Flowers racemose, borne on branchlets of the
year after the leaves..... 2. *Padus*.

Drupes dry or nearly so, leaves persistent..... 3. *Laurocerasus*.

PRUNUS (Tournefort) L. Plums and Cherries.

Drupe purple, red, yellow or orange, with a bloom.. *P. tarda*.

Drupe red or orange without bloom.

Leaves oblong to obovate, petioles not glandular.. *P. Americana*.

Leaves ovate-lanceolate to lanceolate, petioles
glandular *P. hortulana*.

1. **Prunus tarda** Sargent. Texan Sloe. A small tree 20° - 25° high with spreading branches, thin, scaly bark, and lustrous branchlets which become dull with age. Leaves oblong to obovate $1\frac{1}{2}$ '-3' long, $\frac{3}{4}$ '- $1\frac{1}{4}$ ' wide, pointed, firm, serrate, yellowish green and smooth above, somewhat hairy along the midrib and prominent veins below. Flowers in clusters of

2 or 3. Fruit variously colored, oblong to subglobose, sour, with flattened wrinkled stone.

Arkansas, Louisiana and Texas.

2. *Prunus Americana* Marsh. A medium sized, broad topped spiny tree 25°-30° high with drooping branches, green twigs and reddish brown branchlets. Leaves oval to obovate, pointed at the apex, 3'-4' long, 1½' wide, sharply serrate with incurved teeth, smooth and yellow to dark green above, paler and somewhat hairy beneath. Flowers white in clusters of 2-5. Fruit globular to oblong, 1' or less long, red, with juicy, acid flesh.

New York west to Montana, south to Florida and west to Texas. Cultivated for fruit and ornament throughout its range.

3. *Prunus hortulana* Bailey. Wild Plum. A small low branched, broad topped tree 20°-25° high with thin dark brown bark and reddish brown twigs. Leaves ovate-lanceolate or oval, 4'-6' long, 1'-1½' wide, firm, long pointed at the apex, serrate with incurved glandular teeth, smooth, dark green above, paler and with hairs in the axils of primary vein beneath. Flowers in 2-4 flowered lateral clusters before the leaves. Fruit globular to subglobose or oval, ¾'-1' in diameter, red, with thin, hard, acid flesh.

In rich moist soil. Illinois to Tennessee, Alabama, Arkansas and Texas.

PADUS Borkhausen. Wild Cherries.

- Sepals not present on fruit, leaves with slender teeth 1. *P. Virginiana*.
 Sepals present on fruit, leaves with coarse teeth.
 Sepals broader than long, leaves with reticulate veins 2. *P. eximia*.
 Sepals longer than broad, leaves not reticulate veined 3. *P. serotina*.

1. *Padus Virginiana* (L.) Roemer. Choke Cherry. A shrub or small tree 20°-25° high with spreading, drooping branches, thin, smooth, dark gray bark and reddish brown twigs. Leaves ovate to obovate, 2'-4' long, 1'-2' wide, thin,

pointed at the apex, serrate with slender teeth, smooth on both sides. Flowers in loose racemes. Fruit globose, $\frac{1}{4}$ '- $\frac{1}{2}$ ' in diameter, red, black, or yellow with thin, juicy, astringent flesh.

Newfoundland to Manitoba and British Columbia, south to Georgia, west to Texas and Colorado.

2. *Padus eximia* Small. Texas Cherry. A rather large round topped tree 60°-80° high with spreading branches and smooth, red-brown twigs. Leaves ovate, some of them varying to oblong, oblong-lanceolate or oval, $1\frac{1}{2}$ '-3' long, blunt at the apex or taper pointed, serrate, smooth on both sides, dark green above, paler beneath. Flowers in drooping racemes. Fruit globose, purple, with sweet flesh.

Found only in rich valleys of southern Texas.

3. *Padus serotina* (Ehrh.) Agardh. Wild Cherry. Black Cherry. A large narrow topped tree 80°-100° high and 4°-5° in diameter, with horizontal branches, and reddish brown, rough, aromatic, bitter bark and twigs. Leaves oblong, or elliptic to obovate lanceolate, 2'-5' long, $1\frac{1}{2}$ '-2' wide, taper pointed, finely serrate with incurved teeth, firm, glossy, smooth on both sides. Flowers white in long racemes. Fruit globose, almost black with sweet, astringent flesh.

Ontario to North Dakota, Florida and Texas. In Texas it is found in the eastern portion and in the mountains of the west.

The wood is strong, hard, close grained, yellowish red, and is used in making furniture, panels and for finishing.

LAUROCERASUS (Tournefort) Reichenbach. Wild Orange.
Wild Peach.

Laurocerasus caroliniana (Miller) Roemer. A beautiful, medium sized tree 30°-40° high with smooth, gray bark, green twigs and reddish brown branches. Leaves leathery, persistent, elliptic, oblong-lanceolate, entire or few teeth, 2'-4' long, pointed at the apex, glossy green above, dull below. Flowers in short racemes. Fruit oblong or oval, black with thick, lustrous skin and thin flesh.

North Carolina to Florida and Texas. Planted throughout its range as an ornamental tree.

MIMOSACEAE. The Mimosa Family.

Trees with alternate compound evenly pinnate leaves and small leaflets. Fruit a bean-like pod.

Leaves with 1 to 2 pairs of pinnae.

Leaflets 5 to 8 pairs, pods tightly twisted..... 1. *Strombocarpa*.

Leaflets 12-20 pairs, pods not twisted..... 2. *Prosopis*.

Leaves 2 to 3 pairs of pinnae, leaflets numerous... 3. *Siderocarpus*.

Leaves with 1 to 4, 2 to 3 or 3 to 4 pairs of pinnae. 4. *Acacia*.

Leaves with 3 to 5 pairs of pinnae..... 5. *Havardia*.

Leaves with 3 to 8 pairs of pinnae..... 6. *Vachellia*.

Leaves with 2 to 20 pairs of pinnae..... 7. *Leucaena*.

1. STROMBOCARPA. Screw Bean.

1. *Strombocarpa odorato* (Torrey) A. Gray. Screw Bean. A shrub or small tree with thick, shaggy, light brown bark, and reddish brown branches which are armed with axillary spines. Leaves bipinnate mostly with 1 pair of pinnae, sometimes 2 pairs. Flowers in slender, stalked, axillary spikes. Fruit a twisted cylindrical pod.

2. PROSOPIS. The Mesquites.

1. *Prosopis glandulosa* Torrey. Mesquite. A low, round topped tree with thick, reddish brown, fissured bark, yellowish green twigs and darker branches which are frequently armed with axillary spines. The leaves are bipinnate with 1 to 2 pairs of pinnae; leaflets numerous. Flowers perfect, borne in slender, green or yellowish spikes. Fruit a straight or slightly curved indehiscent pod.

Mexico north to Nevada, Kansas, Texas and California. It has gradually encroached on the grassy plains and frequently forms dense shrubbery thickets.

The wood is heavy, very hard, close grained, dark red in color, very resistant in contact with the soil, takes a beautiful finish. It is used for furniture, ornaments, gun stocks, grill work, posts and fuel. The beans are used for food.

3. **SIDEROCARPAS.** Texas Ebony.

1. **Siderocarpas flexicaulis** (Bentham) Small. A small evergreen tree or shrub with spreading zigzag branches, armed with short spines. Leaves bipinnate, pinnae 4-6, leaflets few,

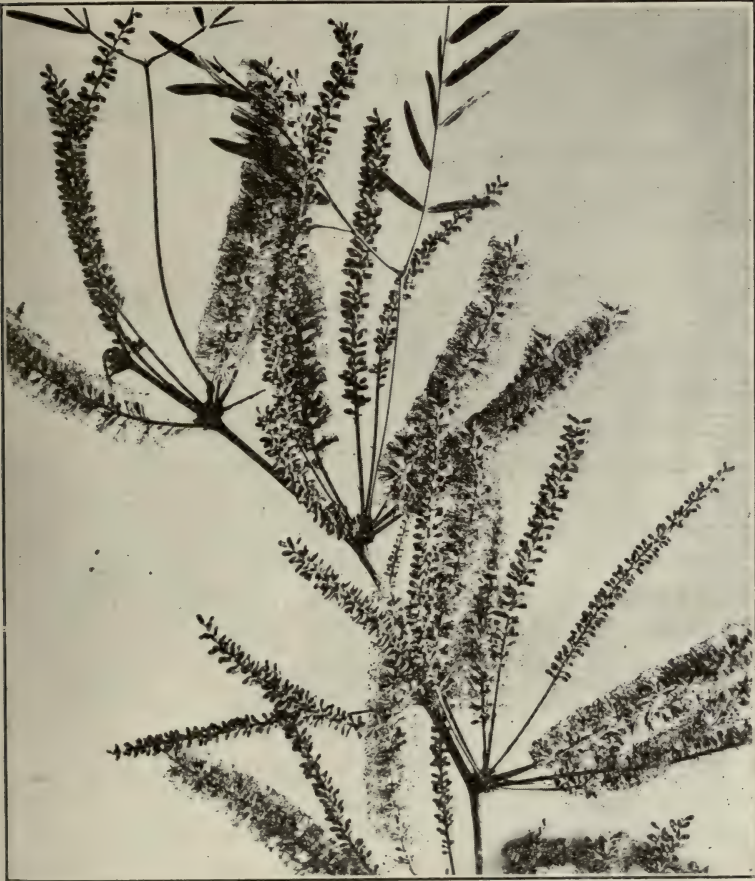


Fig. 35. *Prosopis glandulosa*.

sessil, leathery. Flowers in summer or autumn, in cylindrical shaped spikes. Fruit a flattened, straight, or slightly curved pod. On bluffs of southwest Texas and Mexico.

The wood is dark red to purplish brown, hard, used for cabinet work.

4. **ACACIA** (Tournefort) Adamson. The Acacias.

Thorny trees with alternate evenly bipinnate leaves, numerous pinnae and numerous leaflets. Flowers in globose heads, or cylindrical racemes. Fruit an elongated, flat or cylindrical pod.

Flowers in elongated spikes or racemes.

Pods only slightly curved..... 1. *A. Wrightii*.

Pods much curled and contorted..... 2. *A. Greggii*.

Flowers in globular heads..... 3. *A. Subtortuosa*.

1. **Acacia Wrightii** Benth. Cat's Claw. A small wide topped tree, sometimes 25° high, with furrowed bark; striated, angular branchlets, and short curved spines. Leaves evenly bipinnate with 2-6 pinnae; leaflets 6-12, sessil, firm, light green, hairy, with prominent veins. Flowers borne in racemes in the axils of the leaves, yellowish, fragrant. Fruit a flattened, almost straight pod constricted between the seeds. Western Texas to Mexico.

The wood is close grained, hard, used for fuel.

2. **Acacia Greggii** A. Gray. Paradise Flower. Devil's Claw. A small, thorny tree 20°-30° high with stout reddish brown zigzag branchlets and hairy twigs. Leaves evenly bipinnate, pinnae 2-6, leaflets 8-14, thick, firm, light green. Fruit a very much contorted flattened pod constricted between the seeds. In the ravines from the valley of the San Saba River to the Devil's River and south to Mexico.

3. **Acacia subtortuosa** Shafer. Rio Grande Acacia. A small round topped tree 18°-20° high or a shrub, with dark brown fissured bark, zigzag branches, hairy twigs and light gray spines. Leaves evenly bipinnate, pinnae 6-8, leaflets 9-14 pairs. Flowers in globose heads, in axillary clusters of 1-3, fragrant, bright yellow. Fruit a straight slightly flattened pod, somewhat constricted between the seeds. Along the Rio Grande River, southwestern Texas and adjacent Mexico.

5. **HARVARDI** Small. Huajillo.

1. **Havardia brevifolia** (Benth). Small. A small, evergreen tree with erect branches, thin gray bark and short curved

spines. Leaves evenly bipinnate, pinnae 2-5 pairs, each with 10-20 pairs of sessile light green leaflets. Flowers in head-like clusters. Fruit a flattened, pointed, dehiscent pod. Along the Rio Grande River and Northern Mexico.

The wood is hard, dark reddish brown and very heavy.

6. **VACHELLIA** Wright and Arnott. Huisache.

1. **Vachellia Farnesia** (Linnaeus) Arnott and Wright. A small, round-topped, thorny tree 20°-30° high, with drooping branches and thin bark which peels off in long, reddish brown scales. Leaves evenly bipinnate, pinnae 3-8 pairs, leaflets 20 to 50, light green and smooth on both sides. Flowers yellow in globular heads, very fragrant. Fruit a cylindrical, straight or slightly curved, dark brown or purplish pod constricted between the seeds.

On the plains and prairies of Southern Texas and South to Mexico. Extensively cultivated throughout the tropics.

7. **LEUCAENA** Benth. Lead Trees. Trees or shrubs with evenly bipinnate persistent leaves, slender branches without thorns, flowers in globose heads, and dehiscent, linear, flattened pods.

Pinnae 10 to 20 pairs, twigs wooly..... 1. *L. pulverulenta*.

Pinnae 2 to 10 pairs, twigs smooth.

Leaflets 10-20 pairs..... 2. *L. glauca*.

Leaflets 16-30 pairs..... 3. *L. Greggii*.

1. **Leucaena pulverulenta** (Schlechtendal) Benth. Mexican Lead Tree. A medium sized, round topped tree 40°-50° high with straight trunk, spreading branches and thick light brown scaly bark. Leaves evenly bipinnate, pinnae 10-20 pairs; leaflets 15-30 pairs, small, light green, smooth. Flowers in dense globose heads in the axils of the leaves. Fruit a brown, shining, linear flattened pod.

Along the Rio Grande River, Texas, and Mexico.

2. **Leucaena glauca** (Linnaeus) Benth. Lead Tree. A shrub or small tree with spreading branches, thin, dark brown bark and hairy twigs. Leaves evenly bipinnate, pinnae 3-10 pairs, leaflets 20-40, light green, paler beneath. Flowers in

globose heads, solitary or clustered in the axils of the leaves. Fruit a linear flattened pod pointed at both ends.

In sandy and rocky soils Florida to Texas and Mexico.

CASSIACEAE Link. Senna Family.

Trees or shrubs with alternate, simple or compound leaves; some species armed with prickles. Flowers mostly perfect, in clusters, regular or irregular. Fruit a 2-valved or indehiscent pod.

1. Leaves simple, rhomboidal, heart shaped at base 1. *Cercis*.
2. Leaves pinnate.
 - a. Leaves once pinnate.
 - (1) The axis of the pinnae broad and winged, borne in fascicles, leaflets numerous 2. *Parkinsonia*.
 - (2) The axis of the pinnae not broad and winged, leaflets few..... 3. *Cercidium*.
3. Leaves bipinnate or once pinnate on the same tree 4. *Gleditsia*.

CERCIS L. The Red Buds.

Small unarmed tree with alternate, simple, deciduous leaves which are round in outline and heart-shaped at base. Flowers red or purplish in axillary clusters on branches of preceding year, appearing before the leaves. Fruit a flattened, leathery pod.

Leaves pointed at the apex, pods stalked..... 1. *C. Canadensis*.

Leaves rounded and blunt at the apex.

Pod not stalked..... 2. *C. reniformis*.

1. ***Cercis Canadensis* R.** Red Bud. Judas Tree. A small tree with thin fissured bark, smooth branches, and slender, light brown twigs. Leaves ovate-orbicular to reniform, pointed at the apex, rounded at base, bright green and smooth above, paler and hairy along the veins below. Flowers before the leaves in clusters of 4 to 8, purplish, pedicels somewhat elongated. Fruit a linear oblong pod which tapers at both ends, persistent until winter.

Ontario to Florida, west to Minnesota, Arkansas, and eastern Texas. Principally along streams and in rich bottom

lands. A very desirable ornamental tree or shrub which should be more extensively cultivated.

2. *Cercis reniformis* Eng. Red Bud. A tree resembling



Fig. 36. *Cercis reniformis*.

Cercis canadensis, but with blunt pointed leaves and dense flower clusters.

Texas and Mexico.

PARKINSONIA (Plumies) L. The Horsebeans.

1. *Parkinsonia aculeata* L. Retama. A small thorny, open topped tree or shrub, with thin, reddish brown, mostly smooth bark and yellowish green twigs. Leaves in fascicles,

bipinnate, rachis winged, leaflets numerous, small, rather far apart. Flowers large and showy, bright yellow, in slender upright racemes. Fruit a cylindrical few seeded pod, contracted between the seeds, pointed at base and apex. In the Rio Grande Valley and extending into Mexico. It has been extensively naturalized throughout the southern part of Texas and is planted for ornament.

CERCIDIUM Tulasne.

1. **Cercidium floridum** Benth. A low wide topped tree 15°-20° high with short, crooked trunk, green bark and axillary spines. Leaves evenly bipinnate, pinnae 1 pair bearing 2-4 pairs of small glandular leaflets. Flowers appearing with the leaves and produced for several months in successive crops, rather large, golden yellow, in 3 to 5 flowered racemes. Fruit a flat, straight, dehiscent, 2 to 3 seeded pod, constricted between the seeds.

Southern Texas and adjacent Mexico.

The wood is soft, close grained, used for fuel.

GLEDITSIA (Clayton) L. The Honey Locusts.

Trees with alternate, equally bipinnate or once pinnate leaves; small, greenish, polygamous flowers in slender axillary clusters; simple or branched axillary spines, and elongated or oval pods.

Pod oval or elliptic with 1 or 2 seeds..... 1. *G. aquatica*.

Pod elongated 8 to 12 inches, many seeded..... 2. *G. triacanthos*.

Pod elongated 4 to 5 inches, many seeded..... 3. *G. Texana*.

1. **Gleditsia aquatica** Marsh. Water Honey Locust. A medium sized, wide topped tree 50°-60° high with short trunk, stout branches, reddish brown, fissured bark and straight spines which are usually only slightly branched. Leaves once or twice pinnate, pinnae 3 or 4 pairs, leaflets 3 to 12 pairs. Flowers 1' long, $\frac{1}{3}$ '- $\frac{1}{2}$ ' wide, in slender racemes after the leaves. Fruit an obliquely oval 1 or 2 seeded pod.

In swampy places North Carolina, Florida west to Indiana, Arkansas and Texas. The wood is heavy, hard and strong. Tree sometimes planted for ornament.

2. **Gleditsia triacanthos** L. Honey Locust. A rather large rapidly growing tree 100° or more high with pale rough bark, spreading branches, zigzag twigs and long simple or branched thorns. Leaves mostly bipinnate sometimes once pinnate. Flowers in staminate and pistillate racemes in April. Fruit a long, flattened, more or less twisted pod with a pulp between the seeds.

Ontario to Kansas, Florida and Texas. Extensively planted throughout. Grows well in dry or sandy soil. The thorns are somewhat objectionable. Wood hard, strong, coarse grained, reddish brown.

3. **Gleditsia Texana** Sargeant. Texan Honey Locust. A large narrow topped tree 100°-120° high, with thin, smooth bark and unarmed branches. Leaves once or twice pinnate. Flowers in axillary staminate and pistillate racemes. Fruit a straight, flat pod 4 to 5 inches long without pulp between the seeds. Reported from a single bottom land grove near Brazoria, Texas.

FABACEAE Reichenbach. The Pea Family.

Trees or shrubs with alternate, pinnate leaves, usually perfect pea shaped flowers, borne solitary or in compound clusters. Fruit a dehiscent or indehiscent pod.

Leaves with an odd leaflet at the end..... 1. *Eysenhardtia*.

Leaves without an odd leaflet at the end.

Pods constricted between the seeds..... 2. *Sophora*.

Pods not constricted between the seeds.

Branches with thorns, pods winged on the margin 3. *Robinia*.

Branches without thorns, pods not winged 4. *Coursetia*.

EYSENHARDTIA H. B. K.

1. **Eysenhardtia orthocarpa** S. Watson. A small tree or shrub with thin, gray, scaly bark and reddish brown twigs. Leaves equally pinnate, leaflets 10-24 pairs. Flowers white in dense many flowered axillary spikes. Fruit a short pod, bearing usually a single seed.

Plains and prairies of western Texas and Mexico.

SOPHORA L. The Coral Beaus.

Trees or shrubs with evenly pinnate leaves, showy flowers in clusters, and usually indehiscient constricted pods.

Leaves deciduous..... 1. *S. affinis*.

Leaves thick, persistent..... 2. *S. secundiflora*.

1. ***Sophora affinis*** Torrey and Gray. Deciduous Coral Bean. A small round topped tree with thin, reddish brown



Fig. 37. *Sophora secundiflora*.

bark and green twigs. Leaves deciduous, unequally pinnate, leaflets 11 to 19, stalked. Flowers in axillary drooping ra-

cemes. Fruit a black, shining, indehiscent pod constricted between the seeds.

On limestone hills, valley of the Arkansas River to the San Antonio and westward to the upper Colorado River.

2. *Sophora secundiflora* Dec. Evergreen Coral Bean. Mountain Laurel. A small narrow topped tree 15°-20° or a shrub with upright branches, and velvety twigs which become smooth with age. Leaves evenly pinnate, persistent, leaflets leathery 7 to 13. Flowers in terminl racemes, violet blue, fragrant. Fruit a hard, woody, indehiscent pod much constricted between the seeds.

Matagorda Bay to New Mexico and Mexico. Common on limestone cliffs. Planted for ornament.

ROBINIA L. The Locusts.

Trees or shrubs with alternate unequally pinnate leaves, prickly spines, flowers in drooping axillary racemes, and flat dehiscent pods, winged on one edge.

Flowers white..... 1. *R. Pseudacacia*.
Flowers rose colored..... 2. *R. Neo Mexicana*.

1. *Robinia pseudceacia* L. Locust. A rather large, slender tree 70°-80° high with ascending branches, and deeply furrowed, reddish brown bark. Leaves unequally pinnate, leaflets 7-19. Flowers in loose racemes, white with a yellow spot on the standard, fragrant. Fruit a dehiscent, slightly curved, reddish brown, flat pod.

An eastern tree introduced into our area.

2. *Robinia Neo Mexicana* Gray. New Mexico Locust. A small tree or shrub 20°-25° high with ascending branches, thin, scaly bark and almost straight spines. Leaves unequally pinnate, leaflets 10 to 15. Flowers in rather dense axillary racemes, rose colored. Fruit a dehiscent flat, leathery, light brown pod.

New Mexico, Arizona, Colorado and extending in Texas to the Pecos River Valley.



Fig. 33. *Robinia pseudocacia*.

COURSETIA De Condolle.

1. *Coursetia axillaris*. Coulter and Rose. A small tree or shrub with unarmed zigzag twigs and smooth bark. **Leaves** unequally pinnate, leaflets 7 to 11. Flowers white, in few

flowered racemes, or solitary. Fruit a narrow linear, smooth pod constricted between the seeds.

Near San Diego, Texas.

ZYGOPHYLLACEAE Lindley. The Caltrop Family.

Porleira Ruiz and Pavon.

1. **Porleira augustifolia** (Engelman) A. Gray. A small straggling tree or shrub with smooth branches, leaves opposite, evenly pinnate, leaflets 4 to 6 pairs. Flowers purple, borne on short branches. Fruit a 2-lobed or 4-lobed capsule.

On plains and prairies of western Texas and Mexico.

KOEBERLINIACEAE Engler. The Junco Family.

Koeberlinia Zuccarini.

1. **Koeberlinia spinosa** Zuccarini. A small, low, round topped, thorny tree with reddish brown bark and light green twigs. Leaves alternate, scale-like, soon deciduous. Flowers small, perfect in short racemes at the ends of branchlets. Fruit a globose black berry with thin flesh and one to several seeds.

RUTACEAE Juss. Rue Family.

Aromatic trees or shrubs with simple or pinnate leaves borne alternate to opposite, mostly regular, perfect flowers in compound clusters. Fruit a capsule, berry samara or drupe.

Fruit a dehiscent capsule, 1 to 2 seeded..... 1. *Fagara*.

Fruit an indehiscent samara.

Samara 3 to 4 winged, leaves evergreen..... 2. *Helietta*.

Samara with one wing surrounding the seed.. 3. *Ptelea*.

FAGARA L. Prickly Ash.

Trees with alternate unequally pinnate leaves, small, white, polygamous flowers in terminal or axillary clusters, and corky ridged bark.

Flowers terminal, leaves deciduous..... 1. *F. Clava-Herculis*.

Flowers axillary, leaves evergreen..... 2. *F. Fagara*.

1. **Fagara Clava-Herculis** (L.) Small. Prickly Ash. Toothache Tree. A small round topped tree 25°-30° high with

armed branches, thin light gray bark which bears numerous conic cork based prickles. Leaves deciduous, alternate, unequally pinnate, leaflets 7-19, taper pointed and shallowly toothed. Flowers in terminal panicles, dioecious. Fruit globose capsules borne in dense clusters.

Virginia to Florida and extending along the coast to Texas, and north to Arkansas.

2. Fagara Fagara (L.) Small. Wild Lime. A shrub or small evergreen tree 25°-30° high, with thin gray cork ridged bark, and thorny branches. Leaves evergreen, unequally pinnate; leaflets 5-11, sessile with axis between the leaflets winged. Flowers yellowish in axillary cymes. Fruit an ovoid, rough capsule.

A tropical species found in our area from Matagorda Bay to the Rio Grande River.

HELIETTA. Tulasne.

1. Helietta parviflora Benth. A shrub or small tree 20°-25° high with erect slender trunk, ascending branches, and thin brown bark. Leaves evergreen, small, trifoliate; leaflets sessile, leathery, obovate. Flowers in axillary cymes. Fruit a samara, with wing divided into 3-4 parts.

A Mexican species extending into our area at Rio Grande City.

PTELEA L. Hop Tree.

1. Ptelea trifoliata L. Hop Tree. Wafer Ash. A shrub or sometimes a small round topped tree 20° high with smooth, gray, bitter bark. Leaves deciduous, alternate, trifoliate; leaflets sessile, taper pointed, strong scented when bruised. Flowers greenish white in terminal cymes. Fruit a 2-seeded broad winged samara.

Ontario to Florida, Minnesota, Texas, New Mexico, Colorado and northern Mexico. There is a wide range of variability in the shape and size of the leaves of the species. Frequently cultivated for ornament.



Fig. 39. *Ptelea trifoliata*.

SIMARUBACEAE De Condolle.

Ailanthus Desfontaines.

1. ***Ailanthus glandulosa*** Desf. Tree of Heaven. A large rapidly growing tree with thin pale bark, marked with large lenticels. Leaves large, unequally pinnate, ill-scented, leaflets 13-41, short stalked, pointed, notched at base with green glands on the under side of the teeth. Flowers greenish white in large panicles. . Fruit a linear, curved samara with the seed in the middle. A chinese tree naturalized and frequently planted for ornament. It sprouts freely from the roots and becomes a pest in some localities.

MELIACEAE Ventenat. The Mahogany Family.**Melia** L. China Tree.

Trees with alternate mostly bipinnate leaves, perfect flowers in much branched, axillary panicles and large clusters of globose yellow drupes which remain on the tree after the leaves have fallen.

1. **Melia Azedarach** L. China Tree. Pride of India. A medium sized tree 40°-50° high with smooth twigs and furrowed bark. Leaves large, sometimes thrice pinnate; leaflets notched. Flowers purple in large axillary panicles. Fruit remains on the tree throughout the winter. The seeds are scattered by birds. Robins are said to "get drunk" from eating the fruit.

A native of China naturalized in our area, and frequently found growing spontaneously. It is much planted for shade and ornament.

2. **Melia Azedarach umbreculifera** Sarg. Umbrella China. Similar to *Melia Azedarach* but with depressed umbrella-like top. Very extensively planted for shade.

SPONDIACEAE Kunth. Sumac Family.

Shrubs or small trees with resinous or milky juice; alternate, single or compound pinnate leaves; mostly dioecious flowers borne in axillary, lateral or terminal spikes or racemes, and dense heads of drupaceous fruits.

Leaves simple..... 1. *Cotinus*.

Leaves pinnately compound..... 2. *Schmaltzia*.

COTINUS Adams.

1. **Cotinus cotinoides** (Nutt.) Britton. Smoke Tree. A shrub or small tree with spreading, drooping branches, purple twigs, and light gray furrowed bark. Leaves simple, alternate, oval or obovate, 2'-6' long, entire or with undulate margins, dark green above, paler below. Flowers in few flowered plumose panicles, at the ends of branches, staminate and pistillate borne on different trees. Fruit a drupe.

Missouri, Tennessee, Alabama and Texas. Cultivated for ornament.

SCHMALTZIA Desv. Sumac.

1. **Schmaltzia copallina** (L.) Small. Dwarf Sumac. Usually a shrub, but sometimes a small tree with velvety twigs and reddish brown bark. Leaves alternate, unequally pinnate; leaflets 9-21, sessile, ovate to oblong-lanceolate, the axis



Fig. 40. *Melia Azedarach umbraculifera*.

of the leaf winged. Flowers terminal in dense panicles, the staminate and pistillate on different trees. Fruit bright red drupes in clusters. Ornamental.

2. **Schmaltzia lanceolata** (Asa Gray) Britton. Closely resembles *S. copallina* and sometimes becomes a small tree. Its leaflets are short stalked, narrowly lanceolate, pointed at the apex and somewhat curved.

Found only in Texas, principally on limestone soil.

CYRILLACEAE Lindley. The Titi Family.

Cyrilla L.

Cyrilla racemiflora (L.) Titi. Leatherwood. A shrub or small tree 30°-35° high with thin, pale or whitish bark and reddish brown smooth twigs. Leaves alternate, deciduous, simple, obovate to oblanceolate, 2'-3' long, $\frac{1}{4}$ '-1' wide, leathery with entire margins. Flowers small white or pink in clusters of many elongated racemes. Fruit a blunt ovoid capsule.

In swampy places and along streams. Virginia to Florida and eastern Texas.

AQUIFOLIACEAE De Condolle.

Ilex L. The Hollies. Shrubs or trees with alternate, simple deciduous or persistent leaves, perfect axillary flowers and showy drupaceous fruit.

1. Leaves evergreen.

a. Leaves with spiny toothed margin..... 1. *I. opaca*.

b. Leaves serrate but not spiny..... 2. *I. vomitoria*.

2. Leaves deciduous..... 3. *I. decidua*.

1. **Ilex opaca** Aiton. American Holly. A medium sized narrow topped tree 40°-50° high with light gray roughened bark. Leaves simple, alternate, 2'-4' long, evergreen, stiff and leathery with spiny margin. Flowers small, in axillary cymes. Fruit a bright red drupe which persists throughout the winter. Emblematic of the Christmas season.

Maine to Florida, west to eastern Texas and extending up the Mississippi Valley to Missouri and Indiana. The wood is used for finishing wood and cabinet making.

2. **Ilex vomitoria** Aiton. Yaupon. A shrub or in our area a small tree with small, frequently inclined trunk and numerous, stiff branches. Leaves elliptical to elliptical-oblong, small,

sparingly crenulate, thick, glossy green above, paler below, persistent. Flowers staminate and pistillate. Fruit a small bright red globose drupe. Much prized for Christmas decora-

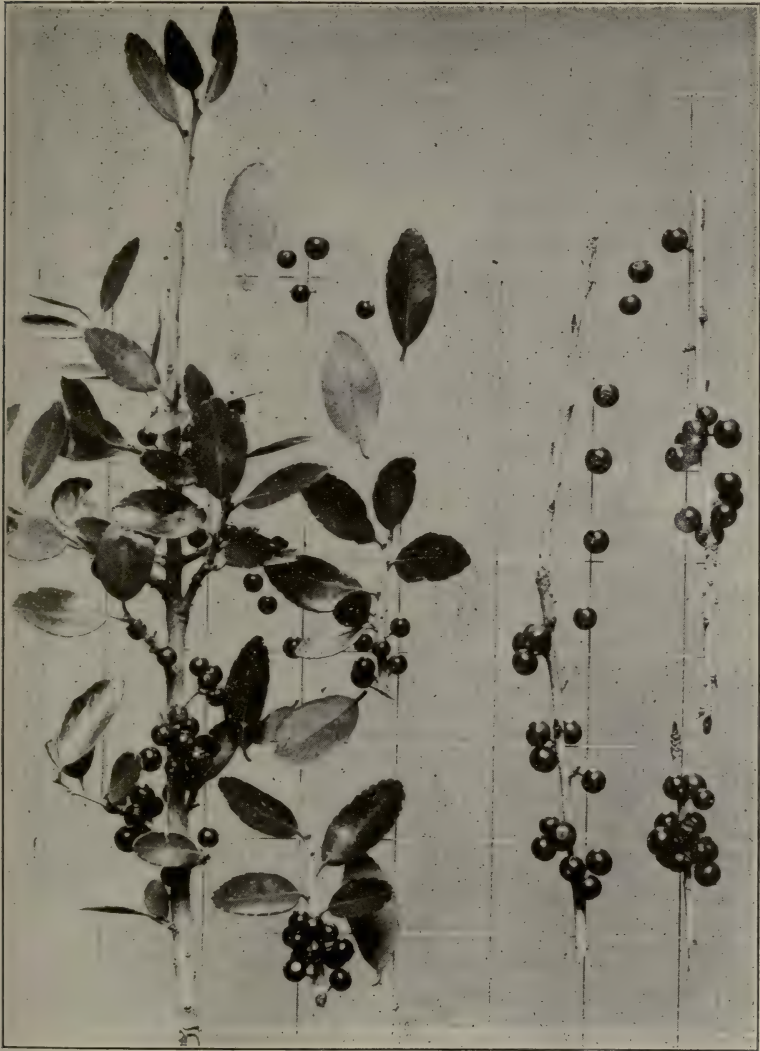


Fig. 41. *Ilex vomitoria* (left). *Ilex decidua* (right).

tion. The glossy green leaves and shining red berries give to the tree a striking beauty.

Virginia to Arkansas and Texas. Cultivated for ornament.

3. **Ilex decidua** Walter. Deciduous Holly. A shrub or small much branched tree with thin warty bark. Leaves obovate, thick, deciduous, notched or blunt at the apex, light green, sparingly serrate, wedge-shaped at base. Flowers staminate and pistillate. Fruit red, or orange colored, globose drupes. Used for decoration but less prized than the preceding species.

In low ground, Virginia, Illinois, Kansas, Florida and Texas.

CELOSTRACEAE Lindley.

Euonymus L. Burning Bush.

Euonymus atropurpurens. Commonly a shrub, but sometimes a small tree 20'-25' high and 4'-6' in diameter with thin gray bark, spreading branches and slender branchlets. Leaves opposite, elliptical, ovate, finely serrate, pointed at the apex, 2'-5' long, 1'-2' wide, light green and smooth. Flowers in axillary cymes. Fruit a fleshy 4-lobed capsule which spreads open when ripe exposing the bright red seeds.

New York to Nebraska, Dakota, Kansas, Florida, Arkansas and Texas.

A beautiful shrub, particularly in autumn after the capsules open.

AESCULACEAE Lindley. The Buckeye Family.

Aesculus. The Buckeyes.

Trees with brown or gray, scaly bark, stout twigs, large scaly buds; opposite palmately compound leaves; large showy flowers in terminal panicles and three lobed, yellowish green capsules.

Flowers reddish.

Leaves densely hairy beneath..... 1. *A. austrina*.

Leaves smooth beneath..... 2. *A. pavia*.

Flowers yellowish..... 3. *A. octandra*.

1. **Aesculus austrina** Small. Southern Buckeye. A shrub or small narrow topped tree sometimes 30° high with stout branches, light brown, smooth bark and drooping branchlets.

Leaves palmately compound; leaflets usually 5, sometimes 3, short stalked, pointed at the apex, unequal at base, serrate, smooth above, hairy beneath. Flowers in terminal panicles,



Fig. 42. *Aesculus pavia*.

red, with tubular calyx, and stamens longer than the corolla. Fruit a pear-shaped capsule with yellowish brown seeds.

Tennessee, Missouri, Louisiana and eastern Texas. In rich soil and along rivers.

2. ***Aesculus pavia*** L. Red Buckeye. A shrub or small

tree with smooth, brown bark, and purple twigs. Leaves palmately compound, leaflets 5-7, firm, pointed at the apex, finely serrate, lustrous and smooth above, almost smooth beneath. Flowers in terminal panicles, red, with stamens as long or longer than the petals. Fruit a smooth oblong, obovate capsule with dark brown seeds.

3. *Aesculus octandra* Marshall. Sweet Buckeye. A large forest tree 100° high or in our area sometimes a shrub with brown, scaly bark. Leaves palmately compound with 5-7 oval to obovate or elliptic leaflets, which are short-stalked or sessile, long pointed at the apex, finely serrate, smooth above, hairy along the veins beneath. Flowers yellowish or purplish in terminal panicles. Fruit a smooth obovoid pod.

In woods and along streams, Pennsylvania, Iowa, Georgia, Louisiana and Texas. In western Texas it becomes a shrub. The tree has been extensively planted for ornament. The wood is very light.

ACERACEAE Tourn. Maple Family.

Trees with opposite, simple or pinnately compound leaves which are usually 3-5 lobed, small flowers in axillary or terminal clusters. Fruit a two winged double samara.

Leaves simple, palmately lobed twigs, reddish

brown Acer.

Leaves pinnate or trifoliate, twigs green or

purplish Rulac.

ACER (Tourn.) L. The Maples.

1. Leaves with large teeth or lobes, the margin entire.
 - a. Leaves large, eastern species.
 - (1) Bark on trunk gray or nearly black... 1. *A. saccharum*.
 - (2) Bark on trunk white..... 2. *A. Floridanum*.
 - b. Leaves small, western trees..... 3. *A. grandidentatum*.
2. Leaves with 3-5 primary lobes, the margins of the lobes serrate or toothed.
 - a. Leaves distinctly 5 lobed, the terminal lobe long and broadest at apex.... 4. *A. saccharinum*.
 - b. Leaves with 3-5 shallow lobes, the terminal lobe broadest at the base.
 - (1) Leaves almost or quite smooth below 5. *A. rubrum*.
 - (2) Leaves persistently wooly below.... 6. *A. Drummondii*.

1. **Acer saccharum** Marshall. Sugar Maple. Hard Maple. A large round topped tree 100°-120° high with brown scaly bark, reddish brown twigs, and sugary sap. Leaves usually 3-lobed, sometimes with 5 lobes, 3'-6' broad, long stalked, rather thin, dark green above, paler and smooth below. Flowers greenish yellow, the staminate and pistillate usually in separate clusters on the same or different trees. Fruit ripening in the late summer or autumn, wings parallel or somewhat divergent.

On uplands New Foundland to Georgia, west to Manitoba, Nebraska and Texas.

The maple sugar and sirup which are staple articles of commerce are made from the sap of this tree. The wood is very valuable, being used for flooring, finishing, and cabinet work.

2. **Acer Floridanum** (Chapman) Fox. Florida Sugar Maple. A medium sized, round topped tree with rough, chalky-white bark and light reddish brown twigs. Leaves rounded, 3-5 lobed, the notches between the lobes rounded, bark green and smooth above, hairy along the veins below. Flowers similar to *Acer saccharum*. Fruit a greenish 2-winged samara, the wings divergent. In lowland, Georgia, Florida, Louisiana and Texas.

3. **Acer grandidentatum** Nuttall. Mountain Sugar Maple. A small tree 30°-40° with scaly, brown bark and reddish branches. Leaves 3-lobed, the lobes with large coarse teeth, notches between the lobes broad and shallow. Flowers similar to *Acer saccharum*. Fruit a two winged, green samara, the wings spreading or erect.

Along mountain streams, Montana, Utah, Arizona, New Mexico, Texas and northern Mexico.

The wood is hard and close grained.

4. **Acer saccharinum** L. Silver Maple. Soft Maple. A large forest tree 100° high with short trunk and large upright branches. Bark on old stems scaly, brown; on young stems and branches, smooth light gray. Twigs reddish, curved upward at the end. Leaves deeply five lobed, the lobes sharp pointed and toothed, smooth and dark green above, pale silvery and smooth below. Flowers greenish in the axils of

the leaves of the preceding year. Staminate and pistillate flowers in separate clusters. Fruit a greenish two winged samara ripening in late spring; wings divergent. In wet



Fig. 43. *Acer saccharinum*.

ground, New Brunswick, Ontario, South Dakota, Florida, Oklahoma and Texas. Many cultivated varieties with finely cut leaves are planted for ornament. A very quick growing tree extensively cultivated.

5. ***Acer rubrum* L.** Red Maple. A large forest tree with upright branches. Bark on young stems gray, smooth, becoming brown and shaggy on older stems. Twigs reddish brown. Leaves 3-5 lobed, the middle lobe longer than the others and tapering toward the broad base, serrate margined, notches wide obtuse angled, medium green and smooth above, paler and somewhat hairy beneath. Flowers scarlet or yellowish, in clusters in the axils of leaves of the preceding year.

Staminate and pistillate in separate clusters. Fruit on long drooping pedicels, ripening in the spring. Wings divergent at maturity.

Most abundant on low wet ground, but sometimes found



Fig. 44. *Acer rubrum*.

growing on hillsides. Québec, Ontario, Florida and west to Iowa and Texas.

The wood is used for furniture, flooring and finishing.

6. *Acer Drummondii* Hooker and Arnot. Drummond's Maple. A medium sized tree with whitish scaly bark. Leaves long stalked, deep green above, whitish and wooly below, 3-lobed, the lobes sharp pointed, and coarsely toothed. Flowers red, in clusters, staminate and pistillate on different trees. Fruit a two-winged samara with slender pedicel and large convergent wings.

In river swamps, Georgia, Florida and Texas.

RULAC Adams. Box Elders.

Twigs and petioles smooth..... *R. Negundo*.

Twigs and petioles hairy..... *R. Texana*.

1. *Rulac Negundo* (L.) A. S. Hitchcock. Box Elder. A medium sized tree with short trunk, widespreading branches,

flaky bark and smooth green twigs. Leaves pinnate, leaflets 3-5 rarely 7, coarsely and sparingly toothed, thin, light green, and smooth above, somewhat hairy along the veins below. Flowers yellowish green in drooping clusters before the leaves, the staminate and pistillate on separate trees. Fruit maturing during the summer and persistent on the branches, twigs somewhat incurved.

In lowlands, Vermont to Florida and west to the Rocky Mountains.

2. *Rulac Texana* (Pox.) Small. Box Elder. Similar to *Rulac negundo* and distinguished from it by the hairy twigs and smaller leaflets which are thick lobed.

Along streams Saskatchewan, Manitoba, Texas and Mexico.

SAPINDACEAE R. Brown. The Soapberry Family.

Trees with alternate compound, pinnate leaves. Flowers regular or irregular in large clusters. Fruit a capsule or a berry.

Fruit berry-like, flowers regular..... 1. *Sapindus*.

Fruit a leathery 3-lobed capsule; flowers irregular. 2. *Ungnadia*.

SAPINDUS L. The Soapberries.

1. *Sapindus Drummondi* Hooker and Arnott. Wild China. A medium sized tree 40°-50° high with upright branches and thick, fissured, flaky bark. Leaves unequally pinnate; leaflets 7-19, short stalked, unequal-sided, entire margined, smooth above, slightly hairy below. Flowers regular, whitish in large dense clusters. Fruit yellow, berry-like, persistent until spring.

Louisiana, Arkansas, Texas, New Mexico, Arizona and northern Mexico.

UNGNADIA Endlicher. Spanish Buckeye.

1. *Ungnadia speciosa* Endlicher. A small tree 25°-30° high with gray, fissured bark and slender, smooth, brown twigs. Leaves unequally pinnate; leaflets 5-7, the lateral ones sessile or almost so, the terminal ones stalked, pointed at the apex, finely serrate. Flowers pink, in large clusters, appearing

with the leaves. Fruit a long stalked 3-lobed leathery capsule which remains on the tree throughout the winter. Along streams and in canyons, Texas, New Mexico and Mexico. Planted for ornament.

FRANGULACEAE. Buckthorn Family.

Trees or shrubs with simple alternate or sometimes opposite leaves, bitter watery juice, small regular flowers and fruit either a drupe or a capsule.

Fruit fleshy with a single stone.

Petals wanting..... 1. *Condalia*.

Petals present..... 2. *Karwinskia*.

Fruit fleshy with 2-3 seed-like nutlets..... 3. *Rhamnus*.

CONDALIA Cavanilles. Purple Haw.

Condalia obovate Hooker. A shrub or small tree 20°-30° high with pale gray bark and spinescent twigs. Leaves small, 1'-1½' long, and ⅓' wide, alternate, obovate or spatulate with entire margin. Flowers small, greenish, solitary in few flowered clusters in the axils of the leaves. Fruit a blue or black oblong drupe ¼' long with sweet flesh.

In dry soils of western Texas and northern Mexico.

KARWINSKIA Zuccarini.

Karwinskia glandulosa Zucc. A small tree or shrub with smooth light brown branches and hairy twigs. Leaves opposite, 1¼'-2½' long, firm, oval, with entire margin. Flowers small green in axillary clusters. Fruit a small subglobose black drupe.

RHAMNUS L.

Rhamnus caroliniana Walter. Indian Cherry. A shrub or small tree 30°-35° high with gray bark, and smooth reddish brown twigs. Leaves alternate, firm, oblong to elliptic, 2'-5' long, narrow at base, smooth and shining above, paler and somewhat hairy beneath. Flowers in small clusters in the axils of the leaves. Fruit globose, bluish black with three

seeds and sweet flesh. Along streams and on hillsides, Virginia to Missouri, Kansas, Florida and Texas. Planted for ornament.

TILIACEAE Jussien. Linden Family.

Tilia L. The Bass Woods.

Trees with mucilaginous sap, tough inner bark, alternate, serrate, unequally cordate, or truncate leaves; flowers in axillary clusters with penduncles attached to a conspicuous bract; fruit nut-like.

Leaves smooth beneath..... 1. *T. Americana*.

Leaves more or less hairy beneath 2. *T. leptophylla*.

1. ***Tilia Americana*** L. A large straight trunked forest tree, usually 60°-70° high with spreading branches, gray bark,



Fig. 45. *Tilia Americana*.

and light gray or brownish twigs. Occasionally larger, 100°-120° high. Leaves orbicular, firm, heart-shaped or truncate at base, sharply serrate, smooth dark green above, yellow-green and lustrous with hairs in the axils of the veins be-

neath. Bract rather large, the peduncle decurrent almost to the base. Fruit hairy. In woods New Brunswick to Manitoba, south to Georgia and west to North Dakota and Texas.

The wood is soft, tough, light, and is used in quantities for furniture and in carpentry. There is no merchantable supply produced in Texas.

2. *Tilia leptophylla* (Vant.) Small. A medium sized forest tree with smooth bark and slender twigs. Leaves thin, ovate, long pointed, toothed, smooth above, more or less hairy beneath. Bracts sessile or almost so. Fruit globose, hairy.

In Louisiana and Texas extending north to Missouri.

BUETTNERIACEAE H. B. K. Chocolate Family.

Firmiana Marsigli. Japanese Varnish Tree.

Firmiana platanifolia (L.) R. Brown. A shrub or small round topped tree 30°-35° high with smooth bark and stout green twigs. Leaves large, alternate, 3-5 lobed, smooth dark green above, hairy and paler beneath. Flowers greenish in clusters. Fruit a capsule which opens at maturity into five leathery follicles exposing the seeds.

Natives of Asia introduced into our area and planted for ornament.

TAMARICACEAE Lindley. Tamarisk Family.

Tamarix L.

Tamarix gallica L. Tamarisk. Salt Cedar. A shrub or low tree with spreading, wand-like branches and numerous branchlets. Leaves scale-like, clasping or sheathing. Flowers pink in dense plume-like clusters. Fruit a pyramidal-shaped capsule.

Native of southern Europe, introduced and growing spontaneously in our area, especially near the coast. Cultivated for ornament.

LAURACEAE Lindley. Laurel Family.

Aromatic trees or shrubs with simple, alternate, opposite

or whorled leaves. Flowers regular, usually in clusters. Fruit a drupe.

Leaves persistent, blades entire, leathery..... 1. *Persea*.

Leaves deciduous, some of them lobed..... 2. *Sassafras*.

PERSEA Gaertner. The Red Bays.

Aromatic trees with alternate, entire, evergreen leaves. Flowers small in panicles. Fruit a subglobose drupe.

Fruit oval or pear shaped, large..... 1. *Persea*.

Fruit ovoid, small..... 2. *Borbonia*.

1. *Persea persea* (L.) Cockrell. Alligator Pear. A medium sized ornamental tree with thin gray bark and smooth branches. Leaves oblong to oval, smooth, reticulated beneath, margins entire. Flowers small, green in leafless clusters. Fruit a rather large drupe. Native of Central America planted for ornament in our range.

2. *Persea borbonia* (L.) Sprengel. Red Bay. Sweet Bay. A medium sized forest tree with thick brown, fissured bark and smooth twigs. Leaves elliptic or elliptic-oblong, entire margins, pointed at base and apex, smooth and dark green above, paler and hairy beneath. Flowers in clusters in the axils of the leaves. Fruit globular, blue or black, lustrous.

In moist soils Virginia to Florida, west to Texas and Arkansas.

The wood is bright red and is used in the manufacture of small trays, mirror frames, canes, and cupboard shelves.

SASSAFRAS Nees and Ebermeir.

Sassafras sassafras (L.) Karsten. Sassafras. A medium sized tree with thick, rough, prominently ridged, brown bark, greenish brittle twigs and mucilaginous sap. Leaves entire or 2-3 lobed, smooth, becoming red or yellow in autumn. Flowers yellow, imperfect, mostly dioecious. Fruit an oblong-globose drupe. The bark of the root yields an aromatic stimulant used in medicine.

In dry soil, Maine to Ontario, Iowa, Nebraska, Florida and Texas.

The wood is deep brown, somewhat resembling ash in its general characteristics.



Fig. 46. *Sassafras sassafras*.

NYSSACEAE Dumort. Dogwood Family.

Trees or shrubs with opposite or alternate entire, firm, leathery leaves; flowers in clusters, with or without involuere; fruit a drupe rarely two seeded.

Leaves alternate..... 1. *Nyssa*.

Leaves opposite.

Flowers in heads, subtended by an involuere
of white bracts..... 2. *Cynoxylon*.

Flowers not subtended by an involuere..... 3. *Svida*.

NYSSA (Granovius) L.

Trees with alternate, mostly entire leaves which are conspicuous for their bright red autumnal coloration. Flowers small greenish. Fruit a black drupe.

Pistillate flowers and drupes in clusters..... 1. *N. sylvatica*.

Pistillate flowers and drupes borne singly..... 2. *N. aquatica*.

1. ***Nyssa Sylvatica*** Marshal. Sour Gum. A large forest tree 80°-100° high with spreading slender branches, greenish



Fig. 47. *Nyssa sylvatica*.

yellow twigs, and dark brown, deeply furrowed bark. Leaves oval to obovate, rounded at the base, 5'-7' long, 2'-4' wide, somewhat pointed at the apex, mostly entire margined, smooth and lustrous above, paler and slightly hairy beneath. Flowers dioecious, the staminate in dense clusters, the pistillate in clusters of three. Fruit in clusters of three, dark blue, with acrid bitter flesh.

In moist places Maine to Ontario, Michigan, Florida, and extending to the valley of the Brazos in Texas. The wood is soft, weak, close grained, used for box boards.

2. **Nyssa aquatica** (L.). Gum. A large, narrow topped tree with dark brown, fissured bark and reddish brown twigs. Leaves thick, firm, ovate to elliptic, pointed at the apex, entire or with angular teeth on the margin, dark green and lustrous above, paler and hairy beneath. Flowers dioecious, the staminate in clusters, the pistillate solitary. Fruit a purple drupe.

In swampy places Virginia to Missouri, Florida and Texas. In Texas it extends to the valley of the Nueces River.

SVIDA Ofiz. Cornel. Dogwood.

Svida stricta (Lam.) Small. Stiff Cornel. Usually a shrub but sometimes a small tree with stiff ascending branches, thin gray bark and reddish twigs. Leaves opposite, elliptic, oval to ovate, long pointed at the apex mostly entire, margined somewhat hairy on both sides. Flowers perfect in terminal clusters. Fruit a pale blue subglobose drupe.

In swampy places Virginia to Missouri, Florida and Texas.

CYNOXYLON Rafinesque.

1. **Cynoxylon floridum** (L.) Raf. Flowering Dogwood. A small round topped bushy tree, 15°-25° high with dark scaly bark, reddish gray branches. Leaves elliptic to oval, 3'-6' long, 1½'-2' wide, with prominent curved primary veins, hairy on both sides, pointed at the apex. Flowers in dense clusters, surrounded by a showy involuere consisting of four white bracts. Fruit ovoid red drupes borne in clusters.

In woods, Massachusetts to Ontario and Missouri south to Florida, Texas and Mexico. A very popular ornamental tree throughout its range.

ERICACEAE De Condolle. The Heath Family.

Arbutus (Tournefort) L. Madrona.

Arbutus texana Buckley. Texan Madrona. A shrub or small evergreen tree 20° high with short, much branched trunk, furrowed, brown bark and red twigs. Leaves ovate to oblong, 1'-3' long, 2/3'-1½' wide, thick, and mostly entire or



Fig. 48. a. *Svida stricta*. b. *Cynoxylon floridum*.

with scattered teeth, dark green and lustrous above, pale and slightly hairy beneath. Flowers in terminal panicles in the early spring. Fruit dark red, ripening in summer, $\frac{1}{3}$ ' in diameter with thin flesh and numerous seeds.

Western Texas and northern Mexico.

hederaceae L. Ivy Family.

Aralia L. Hercules Club.

Aralia spinosa L. A prickly shrub or small tree with thin brown bark and stout twigs. Leaves alternate, large, twice or thrice pinnate, with numerous leaflets. Flowers small, white in large clusters. Fruit an ovoid, 5-lobed, black berry.

In woods and low grounds, New York to Missouri, south to Florida and Texas. Occasionally planted for ornament.

vacciniaceae Lindley. Huckleberry Family.

Batodendron Nuttall.

Batodendron arboreum (Marshall) Nuttall. Tree Huckleberry. A shrub or much branched small tree with thin, close, red-brown bark and smooth, red twigs. Leaves alternate, 1'-2' long, thin, leathery, entire or with glandular teeth, dark green above, paler beneath. Flowers bell-shaped, white or pinkish, in clusters. Fruit subglobose berries with many seeds and dry astringent flesh.

In sandy soil and pine woods, North Carolina, Florida and Texas.

ebenaceae Ventenat. Ebony Family.

Trees or shrubs with watery juice, simple, alternate, entire leaves. Flowers dioecious or perfect. Fruit a one to several seeded berry.

Bark smooth, fruit black..... 1. *Brayodendron*.

Bark divided into fine blocks, fruit orange colored.. 2. *Diospyros*.

BRAYODENDRON Small. Mexican Persimmon.

Brayodendron Texana Small. A much branched shrub or small tree 25°-35° high with smooth gray bark which peels

off in layers. Leaves small, $\frac{1}{2}$ '-2' long, leathery, entire, dark green above, pale and hairy beneath. Flowers dioecious in clusters or solitary. Fruit a globose, black berry $\frac{3}{4}$ ' in diameter, with sweet flesh, and several flattened seeds.

In river valleys Texas and Mexico. The wood is mostly heart wood, variable in color. It is used for tool handles, curtain rings, furniture, pen holders, picture frames and canes.

DIOSPYROS L. Persimmon.

Diospyros Virginiana L. A medium sized forest tree 40°-50° high with spreading branches and thick, dark bark which is broken into numerous small blocks. Leaves ovate to oval, smooth, pointed, dark green above, paler beneath. Flowers yellowish green, dioecious, the staminate and pistillate borne on separate trees. Fruit fleshy, orange colored, one seeded, very astringent when green, sweet and edible when ripe.

In woods Connecticut to Iowa, Florida and Texas. The heart wood is dark, the sap white. Sometimes used for mallets and gavel.

SAPOTACEAE Reichenbach. The Sapodilla Family.

Bumelia Swartz. The Bumelias.

Shrubs or trees with milky sap, entire mostly alternate, or fasciated leaves and perfect axillary flowers. Fruit a fleshy black drupe with one seed.

1. Leaves smooth or almost so beneath.
 - a. Leaves persistent..... 1. *B. angustifolia*.
 - b. Leaves deciduous.
 - (1) Leaves prominently net veined..... 2. *B. lucida*.
 - (2) Leaves not prominently net veined.... 3. *B. lycioides*.
2. Leaves densely hairy beneath.
 - a. Leaves small wedge shaped at base..... 4. *B. rigida*.
 - b. Leaves larger 2'-4' long, not wedge shaped.. 5. *B. lanuginosa*.

1. **Bumelia angustifolia** Nuttall. Saffron Plum. A small evergreen tree 20° high with reddish gray, fissured bark and spinescent branchlets. Leaves obovate or oblanceolate-spatulate, entire, leathery, persistent for about two years, 1'-1 $\frac{1}{2}$ '

long, $\frac{1}{4}$ '- $1\frac{1}{4}$ ' wide. Flowers in the autumn in few or many flowered fascicles. Fruit oblong, black, ripening in the spring.

Florida and the Keys and also in the Rio Grande Valley, Texas and Mexico. The wood is heavy, coarse grained, not strong, light brown, or orange colored.

2. Bumelia lucida Small. Shining Bumelia. A small tree 20°-30° high with stiff thorny branches and smooth bark. Leaves elliptic pointed or blunt at the apex, 1'-2' long, leathery, entire, smooth, dark green and lustrous above, paler and with prominent netted veins beneath. Fascicles many flowered. Fruit mostly oval.

In woods of Louisiana and eastern Texas.

3. Bumelia lycioides (L.) Gaertner. Southern Buckthorn. A small tree 25°-30° high with short trunk, stout branches, and thin, grayish, smooth bark. Leaves oblong elliptic, $1\frac{1}{2}$ '-4' long, $\frac{1}{2}$ '- $1\frac{1}{2}$ ' wide, leathery, mostly pointed at the apex, tapering at base, pale green with prominent netted veins. Flowers in many flowered fascicles appearing in the spring. Fruit an oval berry, ripening in the autumn. Illinois south to Florida and Texas. Wood heavy, hard, weak, close grained, brown or yellow.

4. Bumelia rigida (A. Gray) Small. Arizona Buckthorn. A small tree 25° high with short trunk, flaky, red brown bark and stout stiff thorny branches. Leaves thick, leathery, 1' long, $\frac{1}{4}$ ' wide, cuneate or oblong, smooth above, wooly beneath. Flowers in few flowered fascicles. Fruit oblong-oval to oval, black.

Along streams Texas to Arizona and northern Mexico. Wood hard, close grained, weak, brown or yellow.

Texas, Arizona, and Northern Mexico.

5. Bumelia lanuginosa (Michaux) Persoon. Wooly Buckthorn. A medium sized tree 50°-60° high with straight trunk, fissured bark, and short stiff branches. Leaves oblong-ovate or wedge-obovate, 1'- $2\frac{1}{2}$ ' long, $\frac{1}{3}$ '- $\frac{3}{4}$ ' wide, entire margined, dull dark green above, rusty wooly beneath. Flowers in fascicles of 16-18. Fruit oval, obovoid-oblong, black with thick flesh.

Missouri, Kansas, Florida, and Texas. Wood heavy, weak,

close grained, yellow or brown. A gum exudes from freshly cut wood.

STYRACEAE A. De Condolle. The Storax Family.

Mohrodendron Britton. Silverbells.

Trees or shrubs with alternate, membranous, deciduous leaves, flowers in lateral drooping clusters and dry nut-like fruit, 2-4 winged.

Fruit 2-winged..... 1. *M. dipterum*.

Fruit 4-winged..... 2. *M. Carolinum*.

1. **Mohrodendron dipterum** (Ellis) Britton. Snowdrop Tree. A shrub or small tree 20°-30° high with scaly, reddish brown bark and light green twigs which finally become reddish brown. Leaves firm, ovate to obovate, pointed at the apex, 4'-5' long, 1½'-3' wide, coarsely toothed, light green and smooth above except along the veins, hairy beneath. Flowers white, showy, in clusters. Fruit an oblong or elliptic, 2-winged drupe.

In moist places, Tennessee, South Carolina, Florida and Texas. Frequently planted for ornament.

2. **Mohrodendron Carolinum** (L.) Britton. Silverbell Tree. A shrub or small tree with ascending branches and reddish brown scaly bark. Leaves thin, oval to obovate, pointed at the apex, finely toothed, smooth above except along veins, 4'-6' long, 2'-3' wide, hairy beneath. Flowers white, showy, bell-shaped in clusters. Fruit an oblong ovoid drupe, 4 winged.

In woods, Virginia to Illinois, Florida and Texas. Planted for ornament.

OLEACEAE Lindley. The Olive Family.

Trees or shrubs with mostly opposite, simple or compound leaves. Flowers in clusters, perfect or dioecious. Fruit a samara or a drupe.

Fruit a dry samara, leaves compound..... 1. *Fraxinus*.

Fruit fleshy, leaves simple.

Flowers white, showy..... 2. *Chionanthus*.

Flowers greenish, small..... 3. *Adelia*.

FRAXINUS (Tourn.) L. Ash.

Trees with opposite, odd pinnate leaves, and furrowed bark; flowers in axillary clusters, and staminate and pistillate on different trees: fruit a samara.

1. Petioles and leaf rachis winged..... 1. *F. Greggii*.
2. Petioles and leaf rachis not winged.
 - (1) Lateral leaflets sessile or short stalked.... 2. *F. velutina*.
 - (2) Lateral leaflets distinctly stalked.
 - a. Shoots and main axis of leaf hairy or velvety 3. *F. Pennsylvania*.
 - b. Shoots and main axis of leaf smooth.
 - (a) Wing of the fruit extending down on the body almost to the base.
 - x. Body of the fruit flattened.
 - m. Leaflets 5-7..... 4. *F. Caroliniana*.
 - n. Leaflets 3-7..... 5. *F. cuspidate*.
 - y. Body of the fruit round or nearly so.
 - m. Leaflets 3-5..... 6. *F. Berlandieri*.
 - n. Leaflets 5-7..... 7. *F. Toumeyi*.
 - (b) Wing of the fruit terminal or nearly so.
 - x. Leaflets mostly 5 sometimes 7.. 8. *F. Texensis*.
 - y. Leaflets 5-9 mostly 7..... 9. *F. Americana*.

1. **Fraxinus Greggii** Gray. Gregg's Ash. A small tree 20°-25° high with thin, gray, scaly bark and smooth twigs. Leaves with petiole and rachis winged, leaflets 3-7, sessile. Fruit in small clusters in the axils of leaves. On dry limestone cliffs western Texas and northern Mexico.

2. **Fraxinus velutina** Torrey. Velvety Ash. A round topped tree 30°-40° high and 6'-8' in diameter with stout spreading branches, rough, reddish green bark, and velvety twigs. Leaves unequally pinnate, velvety on lower surface; leaflets 3-9, lanceolate to ovate, sessile, yellowish green, leathery. Flowers dioecious, the staminate and pistillate on different trees. Seed of the samara round, the wing extending down only about one-fourth of the length of the seed. Western Texas, New Mexico, Arizona, Nevada and southern California.

3. **Fraxinus Pennsylvania** Marshall. Red Ash. A medium sized tree 50°-60° high with dense crown, brown fis-

sured bark and hairy twigs. Leaves unequally pinnate; leaflets 5-9, usually 7, stalked, margin entire or somewhat toothed, pointed at the apex, yellowish green on both surfaces, paler beneath than above. Flowers dioecious, appearing with the leaves. Fruit linear to spatulate, the wing extending down on the body to the middle or below. In rich moist soils, New Brunswick, Ontario, Nebraska south to Florida and west to Texas. The wood is used for agricultural implements and vehicles. The tree is frequently planted along streets and in parks, for which purpose it is well suited.

4. **Fraxinus Caroliniana** Miller. Water Ash. Swamp Ash. A round topped tree 40° high with thin gray bark and smooth branches. Leaves unequally pinnate, hairy at first, becoming smooth with age; leaflets 5-7 rarely 9, ovate or oblong, stalked, coarsely serrate, dark green above, paler and sometimes hairy beneath. Flowers dioecious, on different trees. Samara elliptic to ovate, body linear, flat, frequently 3-winged. In moist soil and swampy places, Virginia to Florida and west to the valley of the Sabine River, Texas. The wood is soft and weak and has no commercial value.

5. **Fraxinus cuspidata** Torrey. American Flowering Ash. A small stout tree 20° high with gray bark, smooth twigs. Leaves with 3-5 or 7 leaflets; leaflets ovate to narrowly lanceolate, entire or serrate, pointed, dark green above, paler beneath. Flowers perfect in clusters. Samara flat with short wing. In rocky soil and canyons western Texas, Arizona and northern Mexico. One of the ornamental trees of Mexico.

6. **Fraxinus Berlandieri** de Candolle. Berlandier's Ash. A small tree not over 30° high, with rough gray bark and smooth twigs. Leaves unequally pinnate, smooth or with rusty colored hairs along the veins beneath; leaflets 3-5, stalked, lanceolate to oblong, dark green above, light green beneath. Flowers dioecious, in clusters. Fruit flattened, with the wing twice as long as body, and extending down upon it below the middle. Southwestern Texas and northern Mexico. An ornamental tree of Mexico, and possibly not native to Texas.

7. **Fraxinus Toumeyi** Britton.. Toummeys Ash. A small tree rarely 40° high with rough, gray bark and smooth or

velvety twigs. Leaves unequally pinnate, smooth or velvety below: leaflets 5-7, long pointed, toothed or entire, stalked, yellowish green above, paler beneath. Flowers dioecious. Fruit small, the wing extending down on the round body almost to the middle. In canyons and river valleys, western Texas, New Mexico and southern California. Planted for shade and ornament.

8. **Fraxinus Texensis** (Gray) Sargent. Texas Ash. Mountain Ash. A medium sized tree reaching a height of 50° with thick trunk, spreading branches and dark gray, deeply fissured bark. Leaves with 5-7 ovate stalked leaflets which are entire or toothed, dark green above, pale beneath. Flowers dioecious, appearing in spring with the leaves. Fruit small, the wing as long or longer than the seed bearing portion and terminal upon it. On bluffs and hillsides central and western Texas.

9. **Fraxinus Americana** L. White Ash. A large tree sometimes reaching 120° in height and 5°-6° in diameter with upright or spreading branches, deeply fissured gray bark, and smooth twigs. Leaves unequally pinnate with 5-9, usually 7, leaflets; leaflets ovate to oblong, entire or somewhat toothed toward the apex, usually long pointed, deep green and smooth above, paler and usually silvery beneath. Flowers dioecious. Fruit ripens in early fall; body round, plump, the wing 2-3 times as long as the body, and terminal upon it.

Rich soil Nova Scotia to Minnesota and south to Florida, Kansas, and Texas. The wood is heavy, hard, strong, tough, close grained. One of the most valuable of the hard woods; used for agricultural implements, handles, furniture, vehicle stock and house finishing. The tree is planted for street and shade throughout its range.

ADELIA P. Br.

Adelia acuminata Michx. Crooked Bush. A shrub or small tree 20° high with many crooked, slender branches and smooth bark. Leaves simple, opposite, deciduous, elliptic-oval or ovate elliptic, $1\frac{1}{4}'$ - $3\frac{1}{2}'$ long, pointed at base and apex, slightly serrate. Flowers appearing before the leaves,

dioecious, yellowish or greenish, in clusters. Fruit a deep purple, oblong drupe, $\frac{1}{4}$ '- $\frac{1}{2}$ ' long.

On river banks and moist soil, Illinois, Missouri, Georgia and Texas. Usually a shrub and frequently planted for ornament. It can be trained to form a beautiful hedge.

CHIONANTHUS L.

Chionanthus Virginica L. Fringe Tree. Old Man's Beard. A shrub or small tree 30° high with short trunk, ascending branches, and reddish brown, scaly bark. Leaves opposite, simple, oval, ovate or oblong elliptic, thick, entire margined, pointed at the apex, bright green and smooth above, paler and hairy along the veins below, 2' to 6' long. Flowers in axillary clusters, corolla white, the petals long, linear, fringe-like. Fruit a dark purple drupe $\frac{1}{2}$ ' long. In rocky soil, Pennsylvania, Florida and Texas. The wood is close grained, light brown in color. Frequently planted for ornament in parks and lawns.

EHRETIACEAE Schrad. Ehretia Family.

Trees or shrubs with alternate leaves, watery sap, simple entire leaves and perfect flowers in compound cymes.

Leaves 3'-5' long..... 1. Cordia.

Leaves 1'-2' long..... 2. Ehretia.

CORDIA L.

Cordia Boissieri A. De Condolle. A small round topped, aromatic, evergreen tree 25° high with gray, ridged bark and stout twigs covered with rusty hair. Leaves ovate or oblong-ovate, 3'-5' long, entire or undulate margined, dark green, rough above, with brownish velvety hairs beneath. Flowers showy in clusters; corolla white with yellow center, calyx densely hairy. Fruit an ovoid red-brown drupe 1' long with sweet pulp and smooth stone.

Limestone soils Texas, New Mexico and Mexico. One of the medicinal trees of the Mexicans. The fruit is edible and

the tree is frequently planted for ornament throughout its range.

EHRETIA P. Brown.

Ehretia elliptica De Condolle. Knackaway. A medium sized round topped tree 40° high, 3° in diameter with stout branches, furrowed bark and smooth reddish brown twigs. Leaves oval to oblong, very rough above, leathery, entire margined or toothed, hairy along the veins beneath. Flowers small, white, in clusters, April and later. Fruit subglobose, the size of a pea, with thin juicy edible flesh. Western Texas and northern Mexico. The wood is hard, close grained, but not strong. One of the desirable shade and street trees of its range.

In river valleys western Texas and Mexico. Extensively planted for shade and ornament.

RHINANTHACEAE.

Paulownia Siebold and Zuccarini.

Paulownia tomentosa (Thurnberg) Boillon. A medium sized tree much resembling catalpa and frequently mistaken for it, but readily distinguishable from it by the fruit. The bark is brown and rough, branches stiff, ascending. Leaves large, entire or three lobed, smooth above, slightly hairy beneath with two prominent glands at the base. Flowers large, showy, violet, opening before the leaves. Fruit a large leathery capsule with winged seed.

Native of Japan and China but cultivated in our territory and sometimes growing spontaneously.

BIGNONIACEAE Persoon. Trumpet Creeper Family.

Trees with opposite or alternate leaves, large showy flowers in clusters, fruit an elongated capsule, seeds winged.

Leaves broad, mostly opposite..... Catalpa.

Leaves linear, alternate..... Chilopsis.

CATALPA Scopoli. The Catalpas.

Trees with opposite, simple, broad leaves, large showy

flowers in terminal clusters. Fruit a long round pod which splits into halves; seeds many with a tuft of hair at each end.

Leaves short pointed, flowers bright spotted, wings

of seeds narrowed..... 1. *C. Catalpa*.

Leaves long pointed, flowers nearly pure white,

wings of seeds long..... 2. *C. speciosa*.

1. ***Catalpa catalpa*** (L.) Karsten. *Catalpa*. Indian Bean. A short trunked, round topped tree sometimes 50°-60° high and 3°-4° in diameter with grayish-brown scaly bark. Leaves opposite, broadly ovate, heart-shaped at base, entire or with one or two lateral lobes, light green and smooth above, pale and hairy beneath, foetid when crushed, 5'-6' long, 4'-5' wide on rounded stalks 5'-6' long. Flowers showy in dense many flowered clusters, corolla white, much spotted with yellow and purple. Pod thin, 6'-20' long, splitting into two flattened halves. Seeds about 1' long with pointed wings. Georgia, Florida, Alabama, Mississippi, and extensively naturalized west and north. It is common in many parts of Texas.

2. ***Catalpa speciosa*** Worder. Hardy *Catalpa*. A straight trunked tree which may reach a height of 120° and diameter of 4½°, but is usually smaller. Bark of old trees deeply fissured. Leaves opposite, entire or one to three lobed, broadly or oblong ovate, 4'-12' long, long pointed, dark green and smooth above, lighter and hairy beneath, with clusters of dark glands in the axils of veins. Flowers showy in terminal, few flowered clusters; corolla white with few yellow spots. Pod 8'-20' long, splitting into halves, the seeds with broad wings.

Indiana, Illinois, Missouri, Kentucky, Tennessee, Arkansas and naturalized in Louisiana and eastern Texas. Often planted for timber and ornament. The wood is durable and is used for fence posts.

CHILOPSIS D. Donn. Desert Willow.

Chilopsis linearis (Covanilles) de Condolle. Flowering Willow. Willow-leaved *Catalpa*. A small tree or shrub with short crooked trunk, slender branches, and ridged, scaly bark.

Leaves opposite or alternate, deciduous, linear, 6'-12' long, $\frac{1}{3}$ '- $\frac{3}{4}$ ' wide. Flowers large, showy, in terminal clusters, opening for several months in succession; corolla white tinged with yellow and purple. Fruit a dry thin walled elongated capsule 7'-12' $\frac{1}{4}$ ' thick, persistent on the branches through the winter, seeds winged.

In dry soils western Texas, southern New Mexico, Arizona, Utah, Nevada, California and Mexico. Frequently planted in our area for ornament.

RUBIACEAE B. Jussien. The Madder Family.

Cephalanthus L.

Cephalanthus occidentalis L. Button Bush. A shrub or small tree reaching a height of 40°-50° and trunk diameter of one foot, but usually smaller, with gray brown bark, and stout pithy twigs. Leaves simple, opposite or whorled, ovate or lanceolate, 4'-7' long, 1'- $3\frac{1}{2}$ ' wide, pointed at the apex, smooth above, somewhat hairy beneath. Flowers perfect in axial or terminal globose heads. Fruit a globose head $\frac{1}{2}$ '-1' in diameter.

In swamps and low borders of ponds and streams, New Brunswick, Ontario, Nebraska, Kansas, Florida, Texas, New Mexico and Arizona. Occasionally planted for ornament.

CAPRIFOLIACEAE Ventenat. Honeysuckle Family.

Trees with opposite simple or compound leaves, cymose flowers, and drupaceous fruit.

Leaves pinnately compound..... 1. *Sambucus*.

Leaves simple..... 2. *Viburnum*.

SAMBUCUS (Tournefort) L. The Elders.

1. ***Sambucus Mexicana*** Presl. Mexican Elder. A small tree 25°-30° high with light brown, scaly bark and greenish, hairy twigs which are finally brownish-red. Leaves opposite, unequally pinnate, leaflets usually 5, ovate to ovate-lanceolate, pointed at the apex, toothed, hairy when young and al-

most smooth with age. Flowers white in flat topped hairy cymes. Fruit a small black juicy drupe.

Western Texas, southern California and Mexico.

2. **Sambucus canadensis** L. American Elder. This species occurs from Nova Scotia to Manitoba, Florida west to Kansas and Texas. It is distinguished from the preceding by its smooth foliage and inflorescence.

VIBURNUM L.

Viburnum rudifolium Rafinesque. Black Haw. A small tree 30°-35° high with rough reddish bark and gray twigs. Leaves leathery, variable in form, elliptical-ovate or elliptical-obovate, pointed, sharply and finely serrate, dark green and lustrous above with numerous rusty brown hairs beneath. Flowers perfect in white terminal clusters. Fruit a bright blue drupe, 1/2'-2/3' long, covered with a glaucous bloom.

Virginia, Illinois, Florida, Kansas and Texas. Occasionally cultivated.

GLOSSARY.

- Achene.* A dry one seeded fruit.
- Acid.* Sharp, sour with unpleasant taste.
- Acuminate.* Tapering into a long point.
- Acute.* Sharp pointed.
- Aerial.* Growing in the air.
- Ament.* A spike of flowers all of one sex falling in one piece.
- Anther.* The enlarged portion of the stamen containing pollen.
- Apex.* Tip or upper end.
- Appendaged.* With projections.
- Appressed.* Lying against or close to another part.
- Aromatic.* Fragrant, spicy.
- Ascending.* Growing obliquely upward.
- Astringent.* Drawing together, hence puckering.
- Awl-shaped.* Shaped somewhat like a spine.
- Axil.* The angle between the upper side of the leaf petiole and the stem.
- Axillary.* Borne in the axil of a leaf.
- Axis.* The part of stem or branch which bears foliage leaves, flowers or flower parts.
- Bark.* The rind or outer covering of the stem.
- Basal.* At the base or springing from it.
- Bipinnate.* Doubly or twice pinnate.
- Blade.* The flat expanded portion of the leaf.
- Bract.* A more or less modified leaf found below a flower cluster.
- Branch.* A secondary division of a trunk.
- Branchlet.* One of the ultimate divisions of a branch.
- Bud.* An undeveloped shoot.
- Bud-scales.* Reduced leaves which cover the bud.
- Calyx.* The green saucer shaped outer part of the flower.
- Capsule.* A dry dehiscent fruit consisting of two or more carpels.
- Carpel.* A simple pistil or an element of a compound pistil.
- Catkin.* Same as ament.
- Compound.* Two or more similar parts united.
- Compound leaf.* Consisting of two or more leaflets borne on one stalk.
- Cone.* An elongated axis bearing scales which overlap each other.
- Conifer.* Bearing cones.
- Constricted.* Narrowed.
- Cordate.* Heart-shaped.
- Corolla.* The inner usually colored leaves of the flowers.
- Corymb.* A flat topped flower cluster in which the flowers open from the outside inward.
- Crenate.* Scalloped.
- Cuneate.* Wedge-shaped.
- Cyme.* A flat topped flower cluster blooming from the apex or middle first.
- Deciduous.* Falling off, as leaves in autumn.

Dehiscent. Splitting open as in pods.

Deltoid. Triangular. Delta-like.

Dentate. Toothed.

Dioecious. Bearing stamens and pistils on different plants.

Drupe. A fleshy fruit with one stone as the plum.

Druplet. A small drupe.

Elliptical. Oval or oblong with rounded ends.

Elongated. Long drawn out.

Entire. Without teeth, notches or lobes.

Epidermis. The outer skin or layer of plants.

Equally pinnate. Without an odd leaflet at the end of the leaf.

Exudation. Sap, resin or milk that oozes from a cut surface.

Fasicle. A close cluster of leaves or flowers.

Fascicled. Arranged in fascicles.

Feather-veined. With veins extending from the sides of the midrib.

Fertilization. The union of a male cell, derived from the pollen, with a female cell in the ovule.

Filament. The stalk which bears the anther.

Flower. An axis which bears stamens or pistils or both, with or without petals and sepals.

Fruit. A ripened ovary with or without accessory parts.

Genus. A group of species which are more like each other than like any other group.

Glabrous. Smooth.

Glaucous. With a bloom, a bluish or whitish waxy layer.

Globose. Ball-like or nearly so.

Globular. Ball-like.

Head. A dense cluster of sessile flowers.

Heartwood. The mature and dead wood of a stem usually darkly colored.

Hybrid. A cross between two different species or varieties of plants.

Imbricated. Overlapping like shingles.

Incised. Cut.

Indehiscent. Not splitting open.

Inflorescence. A flower cluster.

Involucre. The bracts which surround a flower cluster.

Irregular. Used to denote flowers in which the petals are unlike.

Keeled. Ridged like the keel of a boat.

Lanceolate. Shaped like a lance.

Leaflet. One of the ultimate divisions of a compound leaf.

Lenticel. Lenticular corky growths on the young bark.

Linear. A leaf several times as long as wide, with sides parallel or nearly so.

Lobe. A division of a simple organ as a leaf.

Lustrous. Shining.

Medullary rays. Rays extending from pith to bark.

Membranous. Papery, membrane-like.

Mid-rib. The main central rib of the leaf.

Monoecious. Stamens and pistils in different flowers on the same individual.

Nectar. The sweet secretion of the flower.

Net-veined. With veins running in various directions and connecting with each other.

Nut. A dry, hard indehiscent 1-seeded fruit with a stony shell.

Nutlet. A very small nut.

Obcordate. Reverse heart-shaped.

Ob lanceolate. Lanceolate, tapering toward the base.

Oblique. Unequal, slanting.

Obovate. Egg shaped with tip downward.

Obovoid. Solid ovate with broader end toward apex.

Odd pinnate. With an odd leaflet at the end.

Opposite. On opposite sides of the stem directly across from each other.

Oval. Broadly elliptical.

Ovate. Egg shaped.

Ovoid. Solid ovate.

Ovule. An immature seed.

Palmate. Lobed or divided like the fingers of the hand.

Panicle. A loose compound flower cluster with the lower branches longer and blooming first.

Peduncle. The flower stalk.

Perfect. A flower which has both stamens and pistils.

Persistent. Leaves which remain on the branches over the first year or a calyx which remains on or under the fruit as in the hawthorn or persimmon.

Petal. One of the separate parts of the corolla.

Pinnæ. The primary divisions of a bipinnate leaf.

Pinnate. A leaf which bears leaflets on both sides of a common petiole.

Pistil. The female organ of a flower, consisting of style, stigma and ovary.

Pistillate. With pistils but without stamens.

Pith. The central cellular part of a stem.

Pod. A dry fruit with one carpel which splits along two sides.

Pollen. The yellowish dust contained in the anther.

Pome. A fleshy fruit with a papery core as the apple.

Puberulent. Slightly pubescent.

Pubescent. Covered with short soft hairs.

Pyriform. Pear shaped.

Raceme. An elongated flower cluster with all the pedicels about equal in length.

Racemose. In a raceme.

Rachis. The axis of a compound leaf or of a spike.

Regular. With all the members alike in shape and size.

Reniform. Kidney shaped.

Resinous. Bearing Resin.

Reticulate. Net-like.

Samara. A winged fruit.

Scale. A minute leaf.

Sepal. One of the parts of the calyx.

Serrate. With teeth like a saw.

Sessile. Without a stalk.

Sheath. A tubular or enrolled part or organ.

Simple. Of one part.

Sinus. The opening between the lobes of a leaf.

Spatulate. Spoon shaped.

Species. A group of individuals which are more like each other than they are like any other group.

Spike. An elongated axis which bears sessile flowers.

Spine. A sharp woody outgrowth from the stem.

Stamen. The organ of the flower which bears the pollen.

Staminate. With stamens but without pistils.

Stigma. The tip of the pistil.

Stipules. A pair of leaf like organs at the insertion of the petiole.

Stomate. A breathing pore in the leaf.

Style. The filamentous portion of the pistil.

Teeth. Projections from the leaf margin.

Thorn. A reduced, sharp pointed branch.

Tomentum. A dense layer of hairs.

Trifoliate. With three leaves.

Truncate. Cut off squarely.

Umbel. A flower cluster in which all the pedicels arise from the same point.

Whorl. A group of three or more leaves or branches radiating from the point of attachment.

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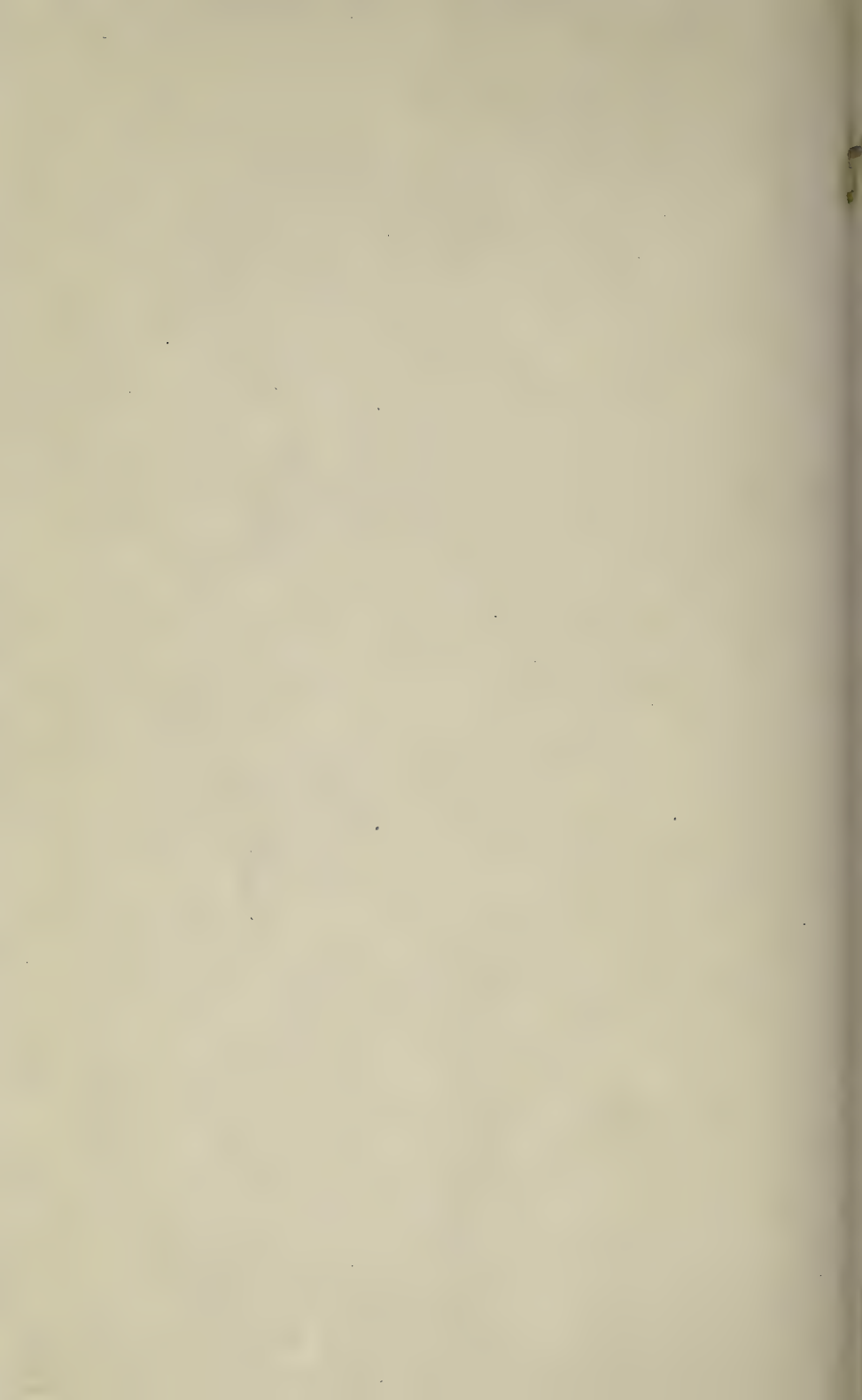
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TEXAS AGRICULTURAL EXPERIMENT STATIONS.

BULLETIN NO. 105.

JUNE, 1908.

NOTES ON
FOREST AND ORNAMENTAL
TREES

ON THE GROUNDS OF THE
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

BY

H. NESS,
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POSTOFFICE

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NOTES ON FOREST AND ORNAMENTAL TREES ON THE GROUNDS OF THE AGRICULTURAL AND MECHAN- ICAL COLLEGE OF TEXAS.

H. NESS.

SOIL AND CLIMATE.

The soil of College Station is fairly typical of the uplands of quite a large area including the greater part of Brazos, Robertson, Madison and Leon with more or less of other adjacent counties. It consists of a surface layer of black, rather stiff, but fairly rich loam varying in depth from six to twelve inches. It becomes deeper, where the surface rises into small, sandy knolls. This loam is underlaid by a subsoil of an exceedingly stiff, impervious gray or yellowish clay which cracks badly during drouths. The whole area is characterized by a dense growth of small, scrubby Post oak and Blackjack, interposed with prairies, which in the summer become covered by wooly-headed Croton and yellow-flowered broom weeds (*Amphiachyris* and *Gutierrezia*). Along the numerous water-courses, which traverse this area, the forests assume a different and quite luxuriant character.

The annual rainfall at College varies between 36 and 40 inches, or about the same as that of the western half of the great forest belt of East Texas. The temperature has varied during the time that our trees have been under observation from slightly below zero to about 100° F.

In the annual report of the Horticultural Department, dated January 1, 1890, is a list given of trees and shrubs planted in the Arboretum and on the campus by the writer, and under the direction of T. L. Brunk, Horticulturist, at that time.

The following are the principal genera represented: Ash, Birch, Beach, Boxelder, Catalpa, Chestnut, China tree, Elm, Hackberry, Japan varnish tree, Locust, Linden, Magnolia, Maple, Mulberry, Poplar, Sycamore, Sweet gum, Willow, Walnut, Arbor Vitæ, Red cedar, Cypress, Pine, Gingo.

Ash.—In the above mentioned list, two species are included, namely, White Ash (*Fraxinus Americana*, L., and *F. lanceolata*, Barkh.). Both of these have made but a slow growth and, with the exception of specimens in favored spots, have shown strong signs of distress during the hot summers, although White Ash is growing to the luxuriant height of 100 feet in the Navasota bottom, only twelve miles from this place.

Birch.—Of the several species of birch, including Paper birch, Polar-leaved birch, European White birch, and Black birch, which is native of our creek bottoms, all failed after a few years, though all made a fair beginning.

Beach and Chestnut.—Made early failures. Horse chestnut lived in a crippled condition for about eight years.

Boxelder, although a native and luxuriant tree of Brazos bottom, has made but a slow growth on our soil. Its foliage assumes during the summer a scorched or otherwise distressed appearance and generally falls prematurely. This tree has been planted extensively for avenues in our towns and for shade trees about residences in the country. It is but seldom, however, that an imposing effect is obtained. It is a fast growth even on our soil when young, but soon reaches its zenith and commences a rapid decline. The foliage, which loses its compactness in midsummer, is too pale for proper effect in our bright light; and, as the wood is brittle, it is also liable to damage by wind.

China Tree, or Umbrella China tree (*Melia Azedarach*, L.), seems to be well adapted to our soil and climate. Its growth, when young, is very rapid; its dark green and dense foliage remains fresh until late in the fall. The beauty is, however, of short duration, for the wood is so brittle that, when full-grown, the branches break down through their own weight, leaving the trunk as an unsightly stump, which is constantly sending out coarse water sprouts.

The China tree has been planted on these grounds both for avenues and shade trees in the houseyards. For the last purpose it may serve for a few years, when more suitable trees can not be obtained, or refuse to grow.

Catalpa.—*C. bignonioides* and *C. speciosa* have both existed on our campus for about twenty years. The largest specimens will scarcely measure 20 feet in height. Though showy at the time of flowering, the *Catalpa* is not an ornamental plant. All the specimens on our grounds are scarcely more than cripples, which lose most of their foliage before September.

We have had a like experience with the *Empress tree* (*Pawlonia imperiales*, Siel and Zuca). A small tree, native of China, similar to the *Catalpa*, but with larger leaves and even more showy flowers. This tree is very sensitive to late frosts, on which account our specimens were finally lost.

Elms.—The following species were planted during 1889 and 1891: English elm (*Ulmus campestris*, L.); Scotch elm (*U. Montana*, L.); American White elm (*U. Americana*, L.); Slippery elm (*U. fulva*, Michx.); Corky-winged or Small-leaved elm (*U. alata*, Michx.). The two first species are native of Europe, the next two are typical of the Northern States, and the last is native of our own locality.

A single suffering specimen is left of *U. campestris*; *U. Montana* and *U. fulva* are dead several years ago. *U. Americana* is the great elm that lends such a grace and charm to the New England towns and villages, where its ample branches lock high above the streets and cottages, forming in the summer a dense canopy of green; whilst the tops equal the church towers. This elm seldom reaches that proportion and beauty in the South, being generally inferior both in size and beauty to our Sweet gums, Black gum (*Nysa sylvatica*, March), Tupelo (*N. aquatica*, L.), and our oaks associated with it in our alluvial bottoms.

On the College campus, extensive avenues were planted with this tree in 1891. Some of the thriftiest specimens may reach 35 feet in height, but all are now on the decline, as shown by the numerous dead twigs in the tops and early loss of foliage.

The *Small-leaved elm*, or Corky-winged elm, is a native of our locality, both in the bottoms and on the uplands. It has also been extensively and for long time cultivated on our grounds. The best specimens planted more than thirty years ago are about 35 feet in height. This elm is hardy, but matures and drops its leaves too early, thus standing naked during the latter part of the summer, giving a distressed and sterile aspect to the landscape.

Hackberry (*Celtis occidentalis*, L.) is a native of Brazos bottom in our vicinity, where the largest specimens may reach a height of 60 feet. The Hackberry was one of the first trees planted on the grounds of the College. I have watched the trees for more than twenty years growing in the main avenue of the College grounds, and have been able in all that time to detect increase in size of but a few of them. Their crowns are of an open, straggling habit; their foliage lacks density and vividness of color, and is dropped early in the season.

The Hackberry is much planted for avenues and shade in our towns, because it can be easily transplanted from the forest at a height of 15 to 20 feet. The effect of such plantations is the same as that stated for the Small-leaved elm.

Black Locust (*Robinia pseudoacacia*, d.).—The Black Locust is more adapted to the cooler climate of the Northern States, where it reaches the proportions of a large tree, than to Texas. Not even in East Texas, where forest trees in general grow so luxuriantly, have I seen a beautiful specimen of this tree, but mostly such as were stunted and crippled, either by bores or from other causes. Most of the specimens on our ground were planted in 1889. Only a few are living, and these in a state of decay.

Maple.—The list of 1890 includes the following species: Sugar maple (*Acer saccharinum*, Wary), Silver maple (*A. dasycarpum*, Ehr.), English maple (*A. compastre*, L.), False sycamore maple (*A. pseudo-platanum* var. *perpureum*); Red maple (*A. rubrum*, L.). As the maples demand a subsoil with an abundant and even supply of moisture, our soil is very uncongenial to them; hence all died after a few years except the Silver-leaved maple, of which a few specimens are still living. Beautiful young trees of this species, and even better ones of the Sugar maple, are growing in Henderson, Rusk county, where also the Red maple is a vigorous native growth in the adjacent bottom lands. Though both Sugar maple and Silver maple are native of a Northern climate, the specimens in Henderson show that they can be planted with advantage in Texas on a soil that makes up the deficiency of the climate.

Mulberry.—The Russian mulberry (*Morus Tartarica*, Land), White mulberry (*M. multicaulis*, Land), and the native Red mulberry (*M. rubra*, L.) are included in the above named list. The Russian mulberry is a small, diffusely branched and unsightly tree or shrub, planted especially for wind-breaks, but has here shown itself unfit for such use, because it is too low, too open, and apt to drop much of its foliage in midsummer. As it is aroused into growth very early in the spring, it is liable to damage from late frosts. *Morus multicaulis* is a tree of no special value, either as an ornamental or for other purposes, except in feeding silkworms. It is liable to damage from late spring frosts and soon becomes unsightly.

The Red mulberry needs a deep moist soil; hence it remains small and not very thrifty on our uplands.

Hardy specimens of the Paper mulberry (*Broussonetia papyrifera* [L], Vent) are found in Bryan, five miles from College. It is a small, but when young a fast growing tree, which soon reaches its maximum size, when its branches begin to break down, and its trunk becomes knotty, hollow, and anything but decorative. What has been said concerning the Umbrella China tree as shade and ornamental trees, applies equally well to the Paper mulberry.

Poplar.—Our list includes the following species and varieties: Cotton Wood (*Populus monelifera*, Ait.); Balsam poplar (*P. balsamifera*, L.); Silver poplar, of which we have two varieties (*P. abba*, L.), the type-form and the pyramidal form; Gray poplar (*P. canescens*, Eng.); Lombardy poplar (*P. nigra fastigata*, Spach). The two first are native of America. Cottonwood grows wild in our vicinity, and the Balsam poplar is a native of the New England and Middle States. The others are imported from Middle and Southern Europe. All of the poplars prefer a moist, cool soil; all grow readily from cuttings.

Out of this number of species only a few specimens of Cottonwood, now past their prime, are yet alive. Of the others a specimen of the Lombardy poplar, having a favorable position, grew to a height of about 50 feet in fifteen years, then died within a few years. Similarly was the behavior of the Silver poplar and its pyramidal variety. These three poplars are all beauties and give a striking effect where used with taste and judgment in ornamental planting; the Lombardy poplar, because of its columnal form; the Silver poplar, because of its color of foliage; and the pyramidal Silver poplar, because of both foliage and form.

Though they are all three too short-lived on our stiff and compact soil, grand specimens can be found in East Texas planted in more suitable ground.

The Sycamore (*Platanus occidentalis*, L.) and the Sweet Gum (*Liquidamber styraciflua*, L.) have been tried with poor success on our ground. They both demand a permeable, moist soil; both are famous for size, beauty, and rapid growth. The former is extensively used in the South for avenues and parks in our cities and towns; perhaps, because it is so easily propagated from cuttings. The second, although it is more ornamental than the Sycamore, having a more symmetrical pyramidal form, a denser and more vividly colored foliage, is almost totally neglected, evidently because it is less cheaply propagated. As to the ornamental value of the Sweet Gum, I find the following remark in the *Journal of the Royal Horticultural Society of England* for the year 1904: "Why this beautiful American tree is not more frequently planted we can not imagine, as it is a hardy, not particular as to soil and makes a beautiful object wherever it grows. Some say: 'Yes, you want a favorable season to get it well calloused'; the truth of which, of course, depends on what is a favorable season for the plant. After the dull summers of 1902 and 1903, the foliage was quite as beautifully colored as usual, and we have never seen a more gorgeous sight than this tree in the Society's Garden at Wisely last autumn; it was one mass of brilliant, glowing crimson. What a glorious feature they would

make as street trees in country towns where the atmosphere is fairly free from pollution! Yet we have never heard of their ever having been tried in such positions, and for all we know they might succeed in smoky towns."

In connection with the Sweet Gum, I can not forbear to mention and recommend for planting on the same class of soils the Black Gum (*Myssa sylvatica*. Marsh.), a large tree with a round head, and remarkably shining dark green and dense foliage, which in the fall assumes a color of deep crimson. Handsome specimens of this tree are found scattered throughout the forests of East Texas.

Tulip Tree (*Liriodendron tulipifera*, L.).—Several specimens of this magnificent tree were planted in 1888 and made such a promising start that about thirty trees were planted in an avenue in 1891. After three or four years they commenced dying, and were soon lost. The Tulip tree is not a native of Texas, but is one of the largest and one of the most beautiful trees in the forests east of the Mississippi river. I have seen vigorous Tulip trees of bearing age on the sandy soil of Watson's Nursery, near Brenham, and also in East Texas, where they were planted on the same class of soil.

Tree of Heaven (*Ailantus glandulosa*, Desf.).—Many specimens of this tree were planted in 1891, because it is reported to be a quick growth and not fastidious as to soil and climate. We are, however, disappointed, as the trees have already ceased their growth, although very few of them exceed 25 feet in height. The lack of growth gives rise to lack of foliage, hence their appearance is naked and unthrifty.

Varnish Tree (*Sterculia platanifolia*, L.).—This is a small to medium-sized tree, native of Japan and China, also called the Chinese parasol tree. It produces a tall, cylindrical trunk, with smooth green bark and thick divergent branches, immense terminal panicles of yellowish, small flowers, and dark green foliage of very large, five-lobed, cordate leaves. Its general appearance gives a strange tropical aspect to the landscape. This tree has been planted on the College grounds in avenues and has proven fairly hardy during the fourteen years that it has been under observation. The specimens will average about 14 feet in height.

Willow.—Of this genus seven species have been tested; all of which were short lived. The one proving the hardiest was the Weeping Willow (*Salix Babylonica*, L.), which if planted on borders of lakes and streams, will prove a very ornamental tree in our climate.

HARDWOODS.

The above species, it will be noted, are nearly all soft woods, and have with few exceptions proven themselves failures on our soils. Of the so-called hardwoods, Black Walnut, Pecan and oaks have been planted. Several Black Walnuts were raised from seed planted in the permanent place in 1889. Many of these are yet living, but in a state of decay or very slow growth.

Two very luxuriant specimens of Pecan, raised from seed, planted in 1892 as above, exist on the campus, one being 33½ feet high. Several other Pecan trees were transplanted from nurseries, but did not recover from the transplanting, as they were rather unthrifty specimens.

European Oak.—Of this we have two species, *Quercus pedunculata*, Ehrh. and *Q. sessiliflora*, Salisb. The first was planted in 1891, and all grew well for about ten years, when some commenced to show signs of decline. In 1889 only one specimen was planted of the second species, which is yet growing thriftily, though in the midst of a thicket of Arbor Vitæ, *Elaeagnus*, and China trees. In the winter of 1902 and 1903 a considerable number of young specimens (1 to 1½ feet in height) of this oak were planted (Plate I). They are all growing luxuriantly, some having now (December, 1907) attained a height of 13 feet. These two oaks, although long considered varieties of the same species (*Q. robar*, L.) do not occupy the identical area of Europe. *Q. pedunculata* is more northern in its habitat, while *Q. sessiliflora* covers Southern Europe and Western Asia.

Turkey Oak (*Q. serris*, L.) covers the same territory of Europe and Asia as the last, and can be distinguished from it by the prominent brownish, woolly stipules. Of this species several specimens were planted in 1891. They grew well for several years, but are now apparently at a standstill after barely having a height of 20 feet, from which it is evident that the Turkey oak is unsuitable to our soil.

Cork Oak (*Q. suber*, L.).—This species is native of Spain, Southern France, Italy, and Northern Africa. Michaux says, in his "Sylva of North America," that the Cork oak will grow wherever the Live oak grows. Like the Live oak, it is one of the hard-leaved evergreens; and like the Live oak, it is transplanted with difficulty. Only one specimen exists of the campus (Plate II). When this was planted, I do not know, but most likely in 1893 or 1894. For several years prior to 1903, I observed this tree to be almost stationary in regard to growth; its main top having been cut off, it seemed to be slowly, but almost in vain, trying to recuperate from the loss. In 1903, this tree measured six feet in height. I did not see it again till 1906, when it had formed a new top and made splendid growth in all its proportions. At the present writing (November, 1907) this oak measures 16 feet in height and the trunk 8½ inches in diameter. The bark of the trunk has a grayish color, with fine streaks or spots of red, and is perceptibly elastic to the touch, owing to the swelling cork. Our specimen is an odd beauty, with a dense, oval crown of dingy green, holly-like, leaves and a stout trunk, which, because of its color, reminds one of a granite column.

Basket Oak or *Cow Oak* (*Quercus Michauxii*, Nutt.).—A native from Delaware to Missouri and southward. A large tree in its native soil. Only one specimen was planted in 1889, and this remained in a crippled condition, due to early injuries, up till five years ago, when it began recuperating. It is now a thrifty, growing tree and bids fair to reach a good size and a long life. It is especially a good omen that it was able to revive after having been stunted for so many years.

Burr Oak.—Mussy-cup oak (*Q. macrocarpa*, Michx.) is found scattered throughout the forests of a large part of Texas. It is one of the white oaks with strong, compact, white wood, and flaky bark. It is found in the situations of considerable aridity, but its preferred habitat is the moist, alluvial bottoms, where it attains a height of 100 feet and a diameter of three to four feet. Our specimens, planted in 1893, are apparently sound and thrifty, but of slow growth, which may be ac-

counted for by the fact that they were planted in dense Bermuda sod and have never received cultivation.

Live Oak (*Q. Virginiana*, Miller).—The Live oak is especially at home on the wet, clayey soils of our alluvial bottoms. It also adapts itself to the limy rocks and arid climate of the West; where, however, it becomes dwarfed and scrubby. Under favorable conditions, it becomes a large, venerable tree, with a somewhat sort, bulky trunk, four to five feet in diameter, a massive, spreading, dome-like crown, a hundred or more feet in diameter.

The Live oak was first planted here in 1891. It is of extremely slow growth in its early youth; but at five or six years old, it commences to grow faster, and having past the age of ten or twelve years, the annual increase in all its proportions is great. It will then yearly add more to its bulk than any of the fast-growing soft woods; and, when these are in their decline, it has barely attained its most vigorous youth. One of our specimens (Plate III), planted in 1891, and standing on the hard-tramped parade ground, has in sixteen years advanced from a sapling 18 inches in height to a tree reaching 28 feet in height, while the spread of its crown is 26 feet in diameter, and the diameter of the trunk, one foot from the ground, is nearly one foot. Other specimens planted later are as tall, but have not yet attained that bulk.

The Live oak has shown itself very hardy on our grounds. Several individuals which once looked like helpless cripples, due to injuries, have now revived and are growing luxuriantly.

From general indications, I conclude that the Live oak is the foliage tree that will attain the greatest longevity on our soil.

Over-cup Oak (*Q. lyrata*, Walt).—This is a native of Navasota bottoms in our vicinity, where it attains a height of 100 feet and about 3 feet in diameter. It is a white oak, a close relative of the Burr oak, with flaky bark and wood celebrated for durability. This oak was planted in considerable number for avenues on the campus in 1902 (Plate IV). The young trees were before planting in a stunted condition, having stood for about two years in nursery rows entirely neglected. In spite of this and the fact that the spring was very dry after transplanting, only a few failed to make a good start. These same plants have made a satisfactory growth ever since, some of them reaching a height of 18 feet.

The Over-cup oak is very variable in habit on our ground; some are pyramidal, while others are umbrella formed, with the main axis divided into numerous divergent, or even somewhat pendulous branches. The trees of this kind have generally a denser foliage of darker green hue.

Pin Oak or Swamp Pin Oak (*Q. palustris*, Du Roi).—This tree is native of moist, swampy soil from Massachusetts south to Arkansas. Several specimens were planted in 1893 and, though in uncultivated ground, have reached a height varying from 22 to 28 feet. Owing to the luxuriant growth of these a considerable larger number were planted for avenues in 1902. These have been cultivated since planting and have now a height of 15 feet (Plate V). The Pin oak is a handsome tree of pyramidal habit, with the lower branches horizontal to pendulous.

Shingle Oak, Northern Laurel Oak (*Q. imbricaria*, Michx.) is a large

tree with lanceolate, entire, shining leaves; native of the Northern States. The few trees of this species, planted in 1891, lingered for six or eight years and then all but one died.

Water Oak, also called Pin Oak in Texas (*Q. nigra*, L., *Q. aquatica*, Michx.).—This tree grows luxuriantly along every watercourse in our vicinity. It is also found growing well in situations where the water has changed its course, or receded, leaving the tree in the dry, sterile soil. In the Navasota bottoms, it is found in greater number along the transitions from bottom to upland than in the midst of the deep alluvium near the river. It is also very common in the stiff, clayey soil along watercourses with no alluvial deposit, where it grows vigorously, even in dry seasons, after the drying up of the creek. The Water oak is one of the noblest ornamental trees of the South, yet seldom planted; because, being an oak, and as such is erroneously and ignorantly supposed to be of too slow growth to afford any enjoyment to the planter. What makes it especially valuable as an ornamental tree is its quick growth, the uniform, pyramidal habit; the striking effect in our bright sunshine of its dense, dark green and almost persistent foliage, and also the ease with which it seems to thrive on a great variety of soils. This oak can also be more readily transplanted than any other oak, with which I have had experience, since the tap root branches into laterals at a very early age.

In 1890 the first Water oak, then a less than a year old seedling 18 inches high, was planted on the campus. This is now, after seventeen years, 32 feet high, with a spread of 32 feet in diameter (Plate VI). It is by far the most handsome tree on the campus. In 1902, after the success of this tree seemed assured, a considerable number of young saplings of the Water oak, varying from 12 to 18 inches in height, were planted. These are now growing as luxuriantly as the first, having in five years attained a height varying from 13 to 17 feet (Plate VII).

White Oak (*Q. alba*, Linn) is a native from Canada almost to the Gulf. In East Texas, where I have observed this tree, it is occasionally found on the uplands, where it appears to grow almost as luxuriantly as on the alluvial soil in the vicinity of swamps and creeks. It is there a magnificent, tall, pyramidal tree with slender, ascending branches, and foliage of a peculiar bright green color, by which it is distinguished from other trees at a great distance. It seems to be of a fast growth, as saplings growing in a thicket of Maples, Sweet gum, and other fast growing plants, generally succeed in holding their own in the skyward race. Several specimens of White oak were planted in 1892, and most of them have made splendid growth, the tallest being 17 feet high (Plate VIII).

CONNIFERS.

Arbor Vitæ (*Biota aureantalis*, Endl.).—Several varieties of this *Arbor Vitæ*, varying in color, in form, and in size from shrubs to trees, have been planted. They are all very hardy on our ground and quite ornamental while young, but with age lose their compactness and become exceedingly ragged and unsightly.

Rosedale Hybrid.—This arose as a natural hybrid in the nursery of William Watson, near Brenham, Texas, and is a cross between *Biota*

orientalis aurea, or Golden Arbor Vitæ, and *Retinospora Juniperoidis*. It is sterile, hence propagated exclusively from cuttings, yet it is variable in form. Most of the plants take after the Golden Arbor Vitæ in form; that is, they are dwarfs, in which the main stem is lost in numerous, erect, laterally, compressed, and compactly standing branches. A few grow to be tall pyramids, or become excurrent with open, horizontal branches, as the type form of *Biota orientalis*. The foliage of all them takes after the *Retinospora*. The compact dwarfs are very ornamental when young, but, in time, they lose their compactness and become unsightly.

It may be of biological interest to cite that about eight years ago Mr. Baker, a nurseryman, of Fort Worth, brought us a Rosedale Hybrid that by bud variation had produced one well-developed branch of the Golden Arbor Vitæ.

Cypress (*Cupressus sempervirens*, Ver. *horizontalis*, Mill.).—Four specimens exist on the campus. One, planted about thirty years ago and standing in Bermuda sod, was severely injured about seventeen years ago by fire, from which it seems to be slowly recuperating. The other three were planted in 1894; the largest of these is 26 feet high (Plate IX).

Cupressus horizontalis is native of the Mediterranean countries of Europe, where it reaches a great age, and attains a height of 75 to 80 feet, and lends an enchanting aspect to the rugged hillsides, where it is especially clustered. It is undoubtedly hardy in our climate, and grows luxuriantly even on our hard, shallow soil. Its hardiness is fully demonstrated by the persistency of the old crippled specimen mentioned above. This tree ought to, at least to some extent, replace the monotonous and prosaic Red cedar which is used so much in our ornamental planting in the South, because it far excels that tree both in growth and in beauty.

Glaucous Cypress (*Cupressus glauca*, Lamyn., *C. luciteanica* and *C. pendula*, L. Huret) is native of India, but has become naturalized in Portugal. A beautiful pyramid tree of rapid growth and with lower branches gradually pendulose; the color of the foliage and young shoots is bright grayish-green.

Our specimen was planted in 1894, and is now 18½ feet tall. When 8 feet tall its top was killed during a severe winter, but it soon recuperated by making a new top. This very beautiful and rapid-growing cypress will undoubtedly be hardy further South, but is here liable to be killed in severe winters.

Lawson's Cypress (*Chamaccyparis Lawsonia*, Murr) was planted at the same time as *C. glauca*, stands close by it, and is nearly of the same height. This cypress has passed through the winters without serious injury. It is a beautiful pyramidal tree, with Arbor Vitæ-like pendulous leaf-branches, of bright green color; thrifty, but scarcely as luxuriant grower as the former.

Deodar Cedar (*Cedrus Deodara*, Laud).—Native of the Western flanks of the Himalaya, where it grows to a height of 150 feet. The Deodar cedar is one of the most handsome and largest evergreens in the world; of pyramidal form, with straight, tapering stem, horizontal, or slightly pendulous branches, and dense bluish-green foliage. We have only one

specimen on the grounds, and this leaves nothing to be desired in beauty or luxuriance (Plate X). It was planted in 1891 and has attained a height of 24 feet. Several plantings were made earlier both of this and its congeners, Cedar of Lebanon and the Atlas cedar; but they failed to recover from the transplanting, owing to the fact that they were too large, and that the cedars are difficult to transplant on our ground unless pot-grown.

Red Cedar (Juniperus Virginiana, L.).—This tree has been planted rather too extensively on our campus. Used for avenues, the Red cedar gives the effect of dreary monotony instead of pleasing uniformity. The same is also the effect when planted together in large groups, unless the trees be restricted to certain forms and compactness by constant pruning or shearing. The Red cedar is very hardy, but also of slow growth on our grounds.

White Cedar (Libocedrus decurrens, Torr.).—The White cedar is a native of the Coast Range and Western slope of the Sierra Nevada, where it is said to attain a height of 100 feet. Only one specimen is found in our collection, this having been planted about thirteen years ago. It appears to be very hardy, is of a beautiful compact form, with laterally compressed branches and vividly green foliage, but of slow growth, having attained a height of only 10 feet. It is evidently the horticultural form *compacta*, which is a dwarf answering the above description.

Pines.—Three species, with one specimen of each, have been under my observation on our grounds; namely, White pine (*P. strobus, L.*); Forest pine (*P. sylvestica, L.*); and *Pinus densiflora, Siel.* White pine is native of the Northern States and Canada, Forest pine is found throughout Europe and Siberia. Both of these were planted in 1889. The first died after two years of struggle with our hot summers; the second is yet alive, but a crooked, unsightly cripple, which is, however, more due to the fact that it was a crooked, knarly nursery specimen to begin with than to the inability of this species to withstand our soil and climate. The fact that it is yet alive and slowly growing corroborates this.

Pinus densiflora, a name given to it because of its immense, dense spikes of staminate flowers, is a native of Japan, where it becomes a large tree of great economic importance. It was planted in 1891, has proved perfectly hardy, although hindered during the first years by too early removal of the lower branches, which weakened the stem, leaving the tree top-heavy and crooked.

GENERAL OBSERVATIONS ON THE GROWTH.

From the above description, it will be noticed that the greater number of the fast-growing, soft-wooded trees, which confine their roots almost exclusively to the surface soil, are failures on our ground. During the spring, when the soil is charged with moisture, these trees make a continuous, rapid growth, which often is suddenly checked by a few weeks of drouth before the newly-formed tissues are sufficiently hardened to withstand the strong transpiration; hence we notice that the leaves of the tender shoots are hurried into too early maturity and

fall off before due time, and that even the extremity of the shoots themselves die in August and September. The hardwoods and many conifers, on the other hand, put on a growth which is determinate for short intervals; that is, shoots of a few inches in length are rapidly made from winter buds, then a period of rest in terminal growth ensues, irrespective of conditions. During this time, the leaves develop their size, the tissues mature, and the terminal buds swell and assume a form similar to the winter buds, but with all their scales unhardened, or embryonic. If the conditions for growth still remain favorable, the period of maturing is again broken by a short period of quick terminal growth; if, on the contrary, a scarcity of moisture occurs, the period of rest will be accordingly prolonged. In this way, the growth of these trees takes place by a series of periods of alternately increasing and maturing their tissues. The arrangement of branches into tiers marks these periods in after life. The above manner of growing is noticeable in most of our oaks, especially in young Live oaks and Water oaks, and in a great number of conifers.

It is not to be supposed that trees with long tap root continue as such for any length of time on a hard, impervious, and sterile subsoil, such as ours; but that the tap root is soon abandoned for surface feeding laterals. The greater success of the oaks is enduring our conditions, I consider mainly due to the intermittent growth, by which they are more enabled to meet extremes than plants of continuous growth. As these trees grow older, the number of periods for a given season becomes reduced; so that, in old, matured trees, only one period occurs, and this in the early part of the season. From these observations, it may be inferred that trees with intermittent growth are well adapted to endure in regions with irregular supply of moisture.

TRANSPLANTING OAKS AND CONNIFERS.

Transplanting is most readily done with all trees when they are quite young; yet some trees can be transplanted with considerable ease later in life, which holds good for most of our soft woods. Hardwoods with long tap root and the evergreens are easily stunted and crippled for life, when transplanted after a growth of several years. It is, therefore, best to transplant them into new nursery rows after the first year's growth; if it should not, at that age, be desirable to put them in permanent place. At that early age, the tap root of oaks produces laterals with greater ease after being cut back than later. Water oak often produces laterals in the first year without transplanting and is, therefore, more easily transplanted than any other oak that I have handled; Live oak, on the other hand, is easily stunted by transplanting, even after only one year's growth. It is, therefore, best to plant the acorns of this oak in boxes 12 to 18 inches deep, sunk into the soil. As soon as the tap root reaches the obstructing bottom of the box, it will bend and generally also produce laterals. Other obstructions may be used; for example, thin sheets of galvanized iron perforated so as to form a sieve and sunk about 18 inches below the seedbed. This is Mr. Risien's method of forcing pecan seedlings to form lateral roots early. It has undoubtedly the advantages over the box methods, as the tap

root does not bend, but forms directly an abundant supply of young lateral roots. Roots grown by both of these methods need no pruning at the time of transplanting.

Before transplanting into permanent place, holes 4 feet deep, or deeper, ought to be dug on such soil as ours, and the holes filled with mellow soil. This will encourage a deep start of the roots and the re-establishment of the tap root. Though such trees as oaks, hickories, and walnuts cease, in time, to make use of this tap root, it is, nevertheless, their great dependence in their early years.

Transplanting of deciduous trees, as well as evergreens, should be done as early in the fall as the trees come to rest. Remaining for a long time healed in is very destructive to their vitality, since the roots, in our climate, as soon as cut off, commence healing the wounds and the generating of rootlets. This exhaustive repair is lost if the trees are disturbed and forced to begin growth anew in a weakened state after transplanting. In no case ought the roots of such trees as hardwoods and evergreens be so exposed to the drying atmosphere that the film of moisture disappears from their surfaces.

Connifers can also with advantage be transplanted in the spring, when the terminal buds indicate that the growth has been resumed. This season is really preferred by many, but at no season should conifers be transplanted in dry, windy weather.

AFTER CARE.

All trees on a soil like ours should receive a constant and careful cultivation until they are so large that the shade from their crowns is sufficient to hold all grasses and weeds in subjugation, then cultivation may be exchanged for mowing.

In pruning to obtain suitable height of the trunk, care must be taken that the removal of the lower limbs be done gradually and in proportion to the thickness of the stem, the amount of foliage and the vigor of the tree. If a mistake is made in this operation, the prospects of a beautiful and long-lived tree is ruined. The too early removal of all the lower limbs to obtain the intended height of trunk, or the removal of too many of them at once, will bring about the ruination of the tree, due to one of two causes: If the tree is vigorous, the removal of too many of its limbs will concentrate the activity of the sap on the remaining upper branches and buds until these are forced into a growth equal to that of the leader, thus taking away the pyramidal symmetry of the tree (see Plates I and VIII). Combined with this injury, the trees is apt to become top-heavy and bent with the prevailing winds, laying the naked stem with the wounds left from the amputated limbs liable to sun-scalding; all of which will, in a short time, cripple or kill the tree. If, however, the tree is less vigorous, stunting from such severe pruning will ensue at once. Heading up of trees should be done gradually as in the forest, where it is done by the gradual shading of the lower limbs. If any lower branch should grow too fast, so as in time to necessitate too heavy amputation, it can readily be kept in check by pinching its terminal shoots during the growing season. The same operation can also be applied to any other branch that threatens to destroy the symmetry of the tree.



Plate I.—Avenue of European Oaks.

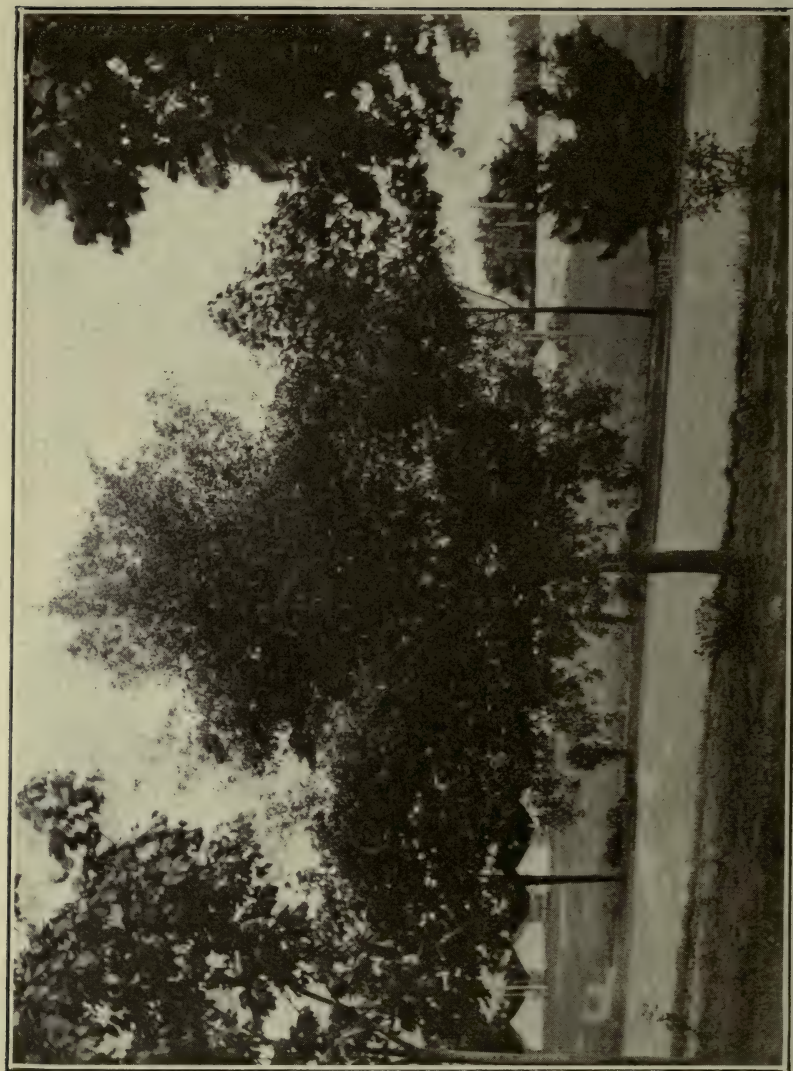


Plate II—Cork Oak.



Plate III—Live Oak.



Plate IV—Avenue of Over-cup Oaks.



Plate V—Avenue of Swamp Pin Oaks.



Plate VI--Water Oak.



Plate VII—Avenue of Water Oaks.



Plate VIII—White Oaks.



Plate IX—Horizontal Cypress.

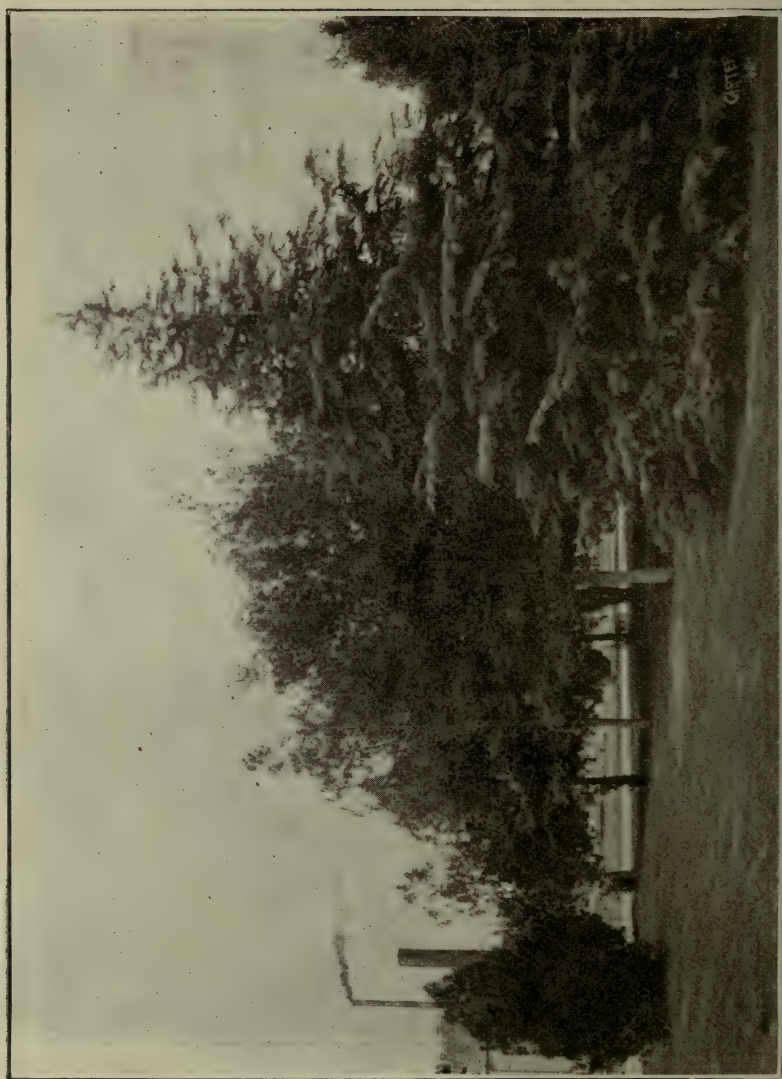


Plate X—Deodar Cedar with Live Oak in the background.

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EAST TEXAS:

ITS TOPOGRAPHY, SOILS, TIMBER, AGRICULTURAL
PRODUCTS, PEOPLE, RAINFALL, STREAMS,
CLIMATE, ETC.

BY

R. T. MILNER



ED. R. KONE

COMMISSIONER OF AGRICULTURE

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PREFACE.

In narrative form, fortified by record data and statistical detail, Col. R. T. Milner supplies this Department as material for this bulletin a comprehensive and intensely interesting history of "East Texas: Its Topography, Soils, Timber, Agricultural Products, People, Rainfall, Streams, Climate," etc.

A no more eminent authority could have undertaken this fascinating task, and at a no more opportune time than the present, when agricultural—or should we say agricultural and industrial?—evolution is rapidly restoring this always romantic region to its prominence among the producing sections of the State.

Colonel Milner's personal recollections go back to the period of the Civil War, prior to which time the primacy of the region described, in agricultural and industrial lines, was rarely, if ever, seriously challenged. From that time, through its transitions of fortune following the reversal of our labor system, leaving it far behind in the struggle for development, he traces the record until he brings it back to photograph a new-old section, marvelously rich in the variety and range of its diversified productivities and the economic opportunities and vocations opened up.

I commend it as of more than historical value, and as especially adapted to distribution along lines of "homeseeker" travel.

ED. R. KONE,
Commissioner of Agriculture.

INTRODUCTION.

A complete, succinct and thoroughly accurate statement of some of the most important features of East Texas is sought to be conveyed in this bulletin. Nearly all descriptions of Texas, or any portions of it, are either written by persons of florid literary tastes or real estate dealers, or persons of intensely sinister motives. What the person in search of a new home desires above all else are plain, unvarnished, truthful statements.

It is a serious matter to leave one's native country in quest of a new home. Ties must be severed, hardships endured, for a while, at least, annoyances incident to breaking up and adjusting one's life and manners to 'fit new conditions,—all these must be considered,—and if, at last, there has been found misrepresentation at the final destination, resentful disappointment and often hopeless despair will be the result. While I have lived in East Texas for sixty-three years, from my infancy to this goodly day, love the country and its people, and have great faith in its future, yet I would not intentionally misrepresent any of its characteristics or exaggerate any of its advantages.

To the person in search of a home in a country such as is briefly described herein, this bulletin, I trust, will appeal with sufficient force to justify a personal investigation. The homeseeker should never hazard his hard-earned money in any country without first visiting it where he can see with his own eye and talk face to face with its inhabitants. First spy out the land. Although nearly all the pioneers had heard but little, few ever returned, and in many instances their descendants are now here to show the homeseeker the country and to bid him a most generous welcome should he decide to stay.

I desire to express my appreciation for valuable data furnished by Mr. E. W. Winkler, State Librarian; Judge Norman G. Kittrell, of Houston, and Mr. T. O. Walton, of Livingston, Agricultural District Agent for that portion of the State, and for the carefully prepared letters of Professors Ness, Kyle and Burns of the Agricultural and Mechanical College of Texas.

R. T. M.

EAST TEXAS: ITS TOPOGRAPHY, SOILS, TIMBER, AGRICULTURAL PRODUCTS, PEOPLE, RAINFALL, STREAMS, CLIMATE, ETC.

East Texas, as I shall denominate it, is all that section lying east of the Trinity river as you ascend that stream from the Gulf of Mexico as far north as the northern part of Henderson county, and thence north to the Red River, including thirty-eight counties. They are alphabetically arranged as follows: Anderson, Angelina, Bowie, Camp, Cass, Chambers, Cherokee, Delta, Franklin, Gregg, Hardin, Harrison, Henderson, Hopkins, Houston, Jasper, Jefferson, Liberty, Marion, Morris, Nacogdoches, Newton, Orange, Panola, Polk, Rains, Red River, Rusk, Sabine, San Augustine, Shelby, Smith, Titus, Trinity, Tyler, Upshur, Van Zandt and Wood.

These counties embrace a territory larger than South Carolina, larger than the States of Massachusetts, Vermont and New Hampshire combined and larger than Scotland. Houston, Jasper, Jefferson, Liberty, Nacogdoches, Red River, Sabine, San Augustine and Shelby were settled as far back as 1836. Nearly all the others were created and organized after the Republic of Texas became a State—from 1845 to 1850. Delta, Gregg, Franklin, Morris and Rains were organized after the Civil War, having been created from portions of the older counties.

Texas stood still from its discovery by La Salle, in 1685, until the beginning of Austin's colony in 1821, a period of 136 years. The population of the entire State in 1821, according to the best authority, did not exceed, including all classes, 5000 people. Fifteen years later, at the beginning of the Republic, the estimated population of Texas was only 52,670, divided as follows:

Anglo-Americans	30,000
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MEXICANS.

At San Antonio.....	2,000
At Nacogdoches	800
At Goliad	500
At Victoria	120
At San Patricio.....	50
	3,470

INDIANS.

Wacoos	400
Tehuacanas	200
Tonkawas	800
Coshattees	350
Alabamas	250
Comanches	2,000

Caddoes	500
Lipans	900
Small bands	800
(And to which the various civilized tribes were added, making in all)	14,200
Negroes	5,000
Total	52,670

These estimates were ascertained by Henry W. Morfit, a gentleman said to be noted for his intelligence, keen observation and shrewd understanding. He was sent to this country by Andrew Jackson, at that time President of the United States, in order to make a report on the condition of the new Republic, its institutions and general prospects.

In 1850 the first official census gave Texas 212,592 people. During the next ten years the increase in population was marvelous, the census of 1860 showing an increase on the previous ten years of 184.2 per cent or a population of 604,251.

By reference to the census of the State, as given in the Texas Almanac of 1858, it will be found that the preponderance of population and wealth existed in the above named counties, although a large area in the southern portion of East Texas was a dense forest.

THE PEOPLE.

The people who settled East Texas immigrated here from the Southern States east of the Mississippi river. They were noted principally for their exalted ideas of morality and hospitality. Frequently there would be settlements all of a kind. Generally those neighborhoods were established on a sound basis, as the company was selected and agreed upon before leaving the old State, and they covenanted together before leaving to the effect that they would aspire to live right, and to establish a broad and liberal civilization, build churches after the manner of those they left, and to erect schoolhouses and to support them in a way to furnish their children the means of an education.

We read in the Texas Almanac of 1858 of a large and flourishing "institute" at Clarksville, the county seat of Red River county, "J. W. P. McKenzie as the principal, with seven assistants, and 210 students." The school consisted of four large frame buildings, and "most of the higher branches" were taught. At the same time and place there were a female institute, and a "commercial law school." At Gilmer, the county seat of Upshur county, there were two schools, one for males and one for females, and "all the branches are taught necessary for a good English education." At this school Judge O. M. Roberts taught a law class in 1868-69-70. At Quitman, the county seat of Wood county, we read: "A fine male and female institute has as many scholars as the teachers can attend to." In nearly every town and community schools and churches were liberally sustained, and much enterprise, refinement and culture existed among the citizens. At Henderson, Rusk, Marshall and other places there were academies presided over by teachers of ability, in nearly every instance college graduates. It was often the

case that a school of note was established in a small village remote from the county seat. When the war between the States broke out two graduates of the University of Michigan were conducting a large school at Church Hill in Rusk county, supported by the planters of the community. The first Teachers' Institute held in Texas was organized at Henderson by several prominent teachers, each of whom was a college graduate. The professional men were usually of a high order, eminent for learning, probity and character.

TOPOGRAPHY.

A complete delineation and description of a country is a most difficult task to perform. A line drawn from the Sabine river commencing about the middle of Sabine county and running west through said county, San Augustine, the lower part of Nacogdoches, through Houston county to the Trinity river, and all north of that line, may be designated the hilly portion of East Texas. This line of demarcation passes through the red-land belt, although areas of it are found much farther north. The red land is a deep, alluvial soil, underlaid with red clay, and is exceedingly fertile. The largest bodies of this land are found in Nacogdoches, San Augustine, Sabine, Houston and Cherokee counties. Anderson and Rusk also contain large areas.

This section with which we are now dealing, all that portion of East Texas north of the above mentioned line, contains the largest variety of soils found in any area of similar size in the Southwest, if not in America. Its perennial springs and never failing streams of flowing water are numerous. The Neches, Angelina and Sabine rivers drain the larger portion of it. In the northern portion the Little and Big Cypress, and the Sulphur accommodate the surplus waters and empty them into the Red River.

The first settlers were attracted hither on account of natural advantages, these being an abundance of timber and water, one considered at that time as indispensable to life and progress as the other. It was more like the land from which they emigrated than any other new country on the continent.

My first recollection of this country was during the Civil War. Deep and lasting were the impressions then formed of the stirring events, the shifting scenes, the occupations of the people, the dependence of a country cut off from every avenue of commerce, and the heavy responsibilities laid upon the old men, women and children, and the proper use and management of the negroes. The country was new, the farms were still "new grounds" and fertile, the virgin soil not yet deprived of its original plant food. Just how to make food, clothing, shoes, hats, plows, wagons, and all the articles necessary to support all the people was the grim problem that confronted society.

But the problem was solved. For meat the forests abounded in cattle and hogs. Sheep furnished wool which was carded and woven by hand and made into winter clothing. Hides were tanned and made into shoes. Cotton was easily produced and the cards and spinning wheels were present in every home to convert it into fabrics. Iron rocks were converted into plows; oak, hickory, ash, and other timber supplied every

need for which wood is used. Corn, wheat, potatoes and all manner of vegetables were produced in astonishing abundance. Wild bees stored away an endless supply of honey in the hollow trees of the forests, which they divided with every ax-man in the land. Domestic animals thrived on the range most of the time and multiplied rapidly. To condense into the fewest possible words what could be lengthened into a long and interesting story, there never existed a country that abounded so lavishly in the necessities of life as did this East Texas country during the war.

These good times, however, could not have lasted much longer, because in the absence of firearms wild game—deer, turkey, squirrels, pigeons, doves, quail, etc.,—had multiplied so rapidly that they were fast becoming a constant menace to crops, and in a few more years they would have completely devoured the products of the fields and gardens in spite of the various contrivances which were already being improvised for their discomfiture.

TIMBER.

Name all the trees that grow in North America, save the spruce, redwood, chestnut and poplar, and you will have a list of trees growing in East Texas. Off-hand, I shall attempt to mention some of them:

Oak—Red-oak, white-oak, black-oak, overcup, chestnut-oak, pin-oak, post-oak, black-jack and blue-jack, belonging to the oak family. Elm—Red-elm, large-leaf-elm, slippery elm. Hickory—White hickory, black hickory, shell-bark hickory and other varieties. Pine—Short and long-leaf, mostly short-leaf in this particular portion. Black walnut, ash, mulberry, hackberry, sweet gum, black gum, ironwood, hornbeam, sugar maple, white maple, beech, catalpa, sycamore, holly, persimmon, sassafras, chinquapin, red and black haw, various kinds of whortleberry, lin, cedar, pecan, cypress, black locust, paw-paw, may-apple, alder, willow, switch and button, wild plum—different varieties—myrtle, birch, red-bud, wild-cherry, sumach and buckeye.

The most numerous are oak, pine and hickory, and are prevalent throughout the section of country under consideration. Nearly all the species growing in the bottoms can be transplanted upon the uplands, and with care and attention will live and thrive. Trees of the pine, oak, hickory, cypress, walnut and gum families grow to an immense size, often measuring over three feet in diameter, and over one hundred feet tall. There are no very large bodies of these timbers now, as they have been consumed by sawmills. The hard timbers never existed in large areas, but flourished in different portions of every county in the district, inhabiting the creek and river bottoms. However, red-oak and hickory frequently of large size and in abundance are found on the uplands.

The pioneers preferred these forests of mixed timber, because they saw in them every essential to a high and progressive civilization. Wood and water were the great natural forces that were to be employed in the development of the country. Land that fostered such timber was known to be productive. Deer, wild turkey, squirrels, coons, opossums, foxes and other wild game excited the sporting spirit ever present in the "Old South," and no amount of timber, no forest, however dense, no trees, however big or tall, baffled the pioneer white man backed by

his negroes. Their forefathers had conquered the swamps from the Potomac to the Mississippi. They entered upon the task with that kind of enthusiasm which genuine, unalloyed hope inspires. It was a task in which every feeling that animates the home-builder in a new country finds lodgment, and which produces energy of the mind, soul and heart.

It was a country without ancient history. The Indians left no mark, except a few mounds, to tell that they ever existed. Everything was primeval. When the pioneers arrived they saw dismal forests through which ran meandering streams as clear as crystal. At first sight it was a charming picture. Wild flowers were in great profusion. Game so plentiful that to slay it seemed brutal. The country was a rolling, hilly land, few marshes and swamps, valleys teeming with wild grass, little underbrush, luscious grapes hanging upon thousands of trees, delicious berries everywhere, and nuts far beyond the needs of squirrels and the animals which feasted upon them. It was, indeed, a scene calculated to inspire the involuntary expression:

"This is a great—a wonderful country!"

This country might be described as one of numerous small hills, interspersed between with small valleys, winding branches and creeks, originally covered with forests but now a land of fields, meadows, etc., separated by forests, in many instances almost as primeval as they were seventy-five years ago, since only about 30 per cent of the country is in cultivation.

There are many remarkable natural features peculiar to this country. Commencing with an imaginary line, which is about 200 feet above sea-line, the surface gradually rises to an elevation of about 600 feet at the highest points, and perhaps 700 feet on the tops of the highest hills in Anderson, Cherokee and Rusk counties.

Such is the remarkable diversity of the soil that it has proved capable of yielding every fruit, vegetable and farm crop in North America, except some grown in Florida. It is not intended to convey the impression that all do well. I have seen growing and ripening peaches, apples, cherries, quinces, pears, grapes, strawberries, blackberries, gooseberries, raspberries, almonds, figs, plums, and pomegranates. I would not undertake to name the various kinds of vegetables, but the most prominent are cabbage, beans, peas, tomatoes, beets, turnips, onions, radishes, lettuce, etc.

The staple farm crops are cotton, corn and oats. But, in addition to these, wheat was an important crop prior to and during the Civil War. While Irish and sweet potatoes have always been considered important crops for home use, they are now beginning to attract wide attention as commercial crops. Ground-peas or goobers, as they are frequently called, are now considered by many farmers as an indispensable crop for stock. Ribbon cane is produced on bottom lands throughout East Texas, and the syrup produced from it is acknowledged to be the most palatable and healthful in the world, superior to the New England maple syrup. Sorghum grows well, but nothing acts to deplete and impoverish the soil more rapidly than this crop. It should never be grown except as is provided by careful rotation, following it with some legume and turning it back to the soil.

It is the opinion of all those who have a knowledge of the essentials of a stock farming country and who have visited East Texas to study and observe its conditions with reference to that business that nature could not have done more toward the accomplishment of that end. The climate is thought to be ideal. The winters are never so severe that domestic animals can not run at large nearly every day, though they would fare better if provided with shelter during the cold rains. The summer months often become very dry, but the heat is not extreme. It should be repeated over and over that this country abounds in numerous springs and streams which never dry up, and that, when no spring happens to be convenient, a well can be dug for a few dollars that will afford water for all necessary purposes. While stock cannot exist on water alone, you cannot escape the inevitable conclusion that a country furnishing so much water must contain a sufficient amount of moisture to produce all known crops. There is then but one other thing to consider in this connection, and that is the soil. For the very best authority, we must go to the Soil Surveys by the Department of Agriculture, Bureau of Soils, Washington, D. C.

Below are given summaries from the surveys of the Henderson area, Harrison county, Titus county, and the Cooper area, which are representative of the entire section. Harrison county is the same character of land as Marion, Panola and Shelby. The Henderson area survey will apply to the most of Sabine, San Augustine, Nacogdoches, Houston, Anderson, Cherokee, Henderson and Smith. The surveys of Titus and Cooper will apply to a large majority of the area north of the Sabine river.

SOIL SURVEY OF THE HENDERSON AREA, TEXAS, MADE IN 1906.

SUMMARY.

The Henderson area embraces the northern part of Rusk county, which lies in the northeastern part of Texas, and entirely within the Coastal Plain. The surface is rolling and the regional drainage is well developed.

The area is sparsely settled, and could easily support four times its present agricultural population. The largest town has but 2200 inhabitants, and the next largest about 500. The population is nearly stationary. Local markets are wanting, and railroad facilities are inadequate.

The staple crops are cotton and corn, which, under present methods of cultivation, give rather low average yields. The boll weevil is partly responsible for the low average in the case of cotton. Near the railroads a considerable development in peach growing has taken place in recent years. Cowpeas, sorghum, sugar cane, and potatoes are also grown to some extent.

The soils lack organic matter, and are farmed without systematic rotation of crops. The aim of the planters is to maintain the crop yields by the use of commercial fertilizers.

The soils all belong to established series—the Orangeburg, Norfolk, Susquehanna, and Lufkin.

In general the Orangeburg fine sandy loam is the best peach soil in this area. The Norfolk fine sandy loam, when not low and flat, the Norfolk fine sand, and the Orangeburg fine sand are also good peach soils. The higher and more hilly parts of this area are better suited for peach growing than the lower areas. The development of the peach-growing industry is seriously hindered by lack of railroad facilities. Peaches cannot be hauled more than three or four miles over these country roads without being injured.

The Cuban filler tobacco, which has been grown successfully in other sections of Texas, can be grown on the Orangeburg fine sandy loam and would prove a very profitable crop and one which can be hauled long distances to railroads without danger of injury.

The Susquehanna fine sandy loam probably finds its best use, under present conditions, in general farming. It is not especially adapted to peaches, although they may be grown on the higher areas. The capacity of this soil to produce hay, peanuts, etc., should be more carefully tested.

The growing of alfalfa is one of the possibilities of the Henderson area. The Orangeburg fine sandy loam, Orangeburg fine sand, and the better drained areas of the Norfolk fine sandy loam, and possibly the Caddo fine sandy loam should grow this crop, if the seed bed were carefully prepared and the seed inoculated. There are many small areas along the smaller streams where the channel is 5 or 6 feet below the level of the bottoms and the latter have a perceptible slope toward the streams. These areas would make fine alfalfa fields. Aside from this crop there are many other grasses and leguminous crops which might be grown in this area with a profit. Among these are redtop, alsike clover, orchard grass, and Japan clover on the Lufkin clay and other wet soils; sand and winter vetch and peanuts on the more sandy soils; and fall oats and Bermuda grass on the other soils. A considerable quantity of hay is shipped into the area, so the growing of hay for the home market should prove profitable.

The growing season is about 240 days and a succession of forage crops can be grown so as to provide pasture for stock nearly all the year, and, under any circumstances, animals require special feeding only when finishing the fattening process and for a few days during severe cold weather. These conditions would seem to favor the extension of the live stock industry.

SOIL SURVEY OF HARRISON COUNTY, TEXAS, MADE IN 1912.

SUMMARY.

Harrison county lies in the short-leaf pine uplands of the northeastern part of Texas. It has an approximate area of 872 square miles or 558,080 acres. The county was settled by immigrants from nearby States and was organized in 1842.

The topography is that of a dissected plain with rolling divides sloping steeply toward the bottoms of the larger streams. Certain sections of the county are hilly. The bottom-land areas are quite extensive. The surface of the greater part of the county is favorable

for farming. Elevations range from 150 feet to 450 feet above sea level. The county is drained by the tributaries of the Sabine and Red Rivers. Drainage over the greater portion of the county is adequate in average seasons, but varies from excessive to insufficient in certain sections, depending upon seasonal conditions.

The climate is mild and the growing season about eight months in length. Farm work may be carried on during every month in the year. The precipitation is usually ample and well distributed.

Between 30 and 35 per cent of the county is cleared. The remainder supports a forest growth consisting of pine and oak, hickory, gum, and other hardwoods. There are very few merchantable trees on the uplands, but some of the bottom lands have a valuable growth of hardwoods. Native grasses are abundant where the forests are not too dense.

The Texas & Pacific, Marshall & East Texas, Missouri, Kansas & Texas, and the Texas & Gulf Railways have a total mileage of over 131 miles within the county. These railroads furnish good shipping facilities in all directions. Marshall, the county seat, is a thriving city of 11,452 inhabitants and is the largest market and shipping point of the county. Hallsville, Harleton, Waskom, Elysian Fields and Scottsville are other local shipping points of the county.

The county is well supplied with schools, churches, rural mail routes, and telephone lines.

The average price of farming land lies probably between \$10 and \$12 an acre, with a range from \$5 to \$25. About 48 per cent of the farms are operated by the owners. The average sized farm is 95 acres, classing each tenancy as a farm. There are a number of large holdings, especially in the eastern half of the county.

Five-sixths of the cultivated land is devoted to the production of cotton and corn. Peanuts, ribbon cane, potatoes, peaches, cowpeas, forage, and truck crops are also grown. The more progressive farmers are now beginning to diversify their crops and to practice rotation. Comparatively little improved farm machinery is used.

The soils of the uplands of the county belong to the Coastal Plains Province and have been derived from the weathering of sand and clay strata of the Eocene age. The lowlands represent reworked material from this and other counties of the State. Including Meadow, twenty-three types have been mapped.

These fall naturally into two divisions, first the sedimentary or upland soils, including the Susquehanna series with five types, the Orangeburg series with four types, the Norfolk with two types, the Ruston series with two types, the Caddo and Lufkin series with one type each; second, the alluvial or lowland soils, including the Sanders series with three types, the Kalmia series with three types, the Trinity series with one type, and Meadow.

The upland soils are fairly productive and easily cultivated. In general they are adapted to staple rather than to special crops, although peanuts, peaches, melons, truck, and other crops give good results on well-drained portions. The lowland soils are productive, but as a rule are poorly drained and subject to overflow. They are adapted

to general farm crops and to ribbon cane. Alfalfa should do well on the Kalmia sand and the fine sand.

To increase the general agricultural production of the county a diversification of crops, which would enable the farmer to raise his home supplies and to make cotton his surplus money crop is necessary. This plan would permit him to practice a rotation of crops, which would increase the productiveness of the soil and enable him to maintain the yield of the cotton crops. Certain areas could be devoted to special crops for local and outside markets.

Other essential factors, which should receive attention, are an increase in the organic-matter content of the upland soils, the prevention of the erosion on the slopes, and the drainage of the alluvial soils.

The prevailing credit system, the outgrowth of tenant farming, with the high rate of interest charged under it, is also a factor retarding the agricultural development of the county.

SOIL SURVEY OF TITUS COUNTY, TEXAS, MADE IN 1909.

SUMMARY.

Titus county is located in the northeastern part of Texas, and with the exception of a few square miles of prairie in the northwestern corner it lies within the hard-timber belt. The greater part of the upland is rolling, but very little is too rough for farming. Drainage is good except on the bottom lands.

Titus county is one of the old counties of Texas, having been organized in 1846. The settlers came mostly from Tennessee, Georgia and Alabama. Agriculture has always been the chief occupation of its inhabitants. Mount Pleasant is the county seat and the largest town. Winfield and Cookville are important shipping points.

The climate is mild, without extremes of heat and cold. The seasons are long enough to permit the maturity of all crops grown in this section and farm work can be carried on during every month of the year. Frosts rarely occur late enough in the spring to cut off the peaches and other fruits.

Cotton and corn are the principal crops. The area is of interest because it is rapidly changing from a one-crop system to a diversification of crops. The old system of growing cotton exclusively, or with a small acreage of corn, is being replaced by rotations that may include peanuts, cowpeas, potatoes, ribbon cane, forage crops, and truck crops. Many peach orchards have been planted and other fruits are grown to some extent.

Thirteen types of soil have been mapped in Titus county. Of the upland soils there are two groups—those of the prairies and those of the wooded areas. On the prairies there are two series, the Wilson, which has two types, and the Lufkin, which has one. The soils are derived from the Cretaceous rocks; they are dark-gray to brown sandy loams and clay loams and the subsoils are heavy in texture and brown in color, the subsoil of the Lufkin series being the more compact.

The soils of the wooded areas are all of a sandy nature and are derived from sandy shales and clays of the Eocene. There are two

principal series, the Norfolk and the Susquehanna. The Norfolk types, of which there are two, have fine sand and fine sandy loam soils underlain by yellow sandy clay. These soils are especially adapted to peaches and truck crops. They also include good crops of cotton and corn. The Susquehanna series includes three types, which have gray or reddish gravelly soils and red and gray mottled clay subsoils.

The black alluvial soil along Sulphur river is called Trinity clay, and the gray to brown types on White Oak creek are classed with the Sanders series. None of these soils have much agricultural value on account of the frequent overflows to which they are subject.

The Meadow bordering all the smaller streams is cultivated in many places. It is not a definite type but consists of soils of all textures, from sands to heavy clays. Portions of it are especially adapted to ribbon cane, and corn produces well on some of the bottoms.

All the upland soils of the area are productive and the sandy soils are remarkably lasting. Up to the present time their fertility has been so well maintained that the farmers have not found it necessary to use commercial fertilizers. With careful management and wise crop rotations this should never be necessary except possibly for special crops.

The changes that will be beneficial to the farmers of the county, briefly stated, are (1) a diversification of crops which will enable the farmer to raise his home supplies and to have, besides cotton, a surplus of other crops to sell, and (2) a closer co-operation among the fruit and truck growers in order to establish standard grades of produce and to ship to the best markets in carload lots.

SOIL SURVEY OF THE COOPER AREA, TEXAS, MADE IN 1907.

SUMMARY.

The Cooper area (400,256 acres, or 625.4 square miles) comprises the southern part of Lamar county, which has the north fork of Sulphur creek for its southern boundary, and all of Delta county, which is triangular in shape, lying directly south of Lamar and between the north and south forks of Sulphur creek.

The area is high, rolling plateau broken by valleys of North Sulphur and South Sulphur creeks and their small tributaries. All the larger streams have low flood plains varying from one-fourth to three miles in width and subject to overflow.

This part of Texas was settled early and the people are of American stock. The prairie portion of the area is thickly settled and many flourishing towns have sprung up. The area approaches within a few miles of Paris, a railroad center and the principal city in this part of Texas. Two railroads pass through the western part of the area, but the eastern side lacks railroad facilities. Cotton is the principal export crop and facilities are ample for ginning and marketing.

The climate of the area is mild during the greater part of the year, the only disagreeable feature being the sudden cold waves or "northers" in the winter months and occasional wind storms. A long growing season occurs between the last killing frost in the spring and the first killing frost in the fall, the average dates being March 26 and

November 14, respectively. Farm work may be carried on at all seasons. Peaches and other fruits are almost sure crops. The rainfall is abundant, averaging more than 32 inches, and damage from summer droughts is rare.

Only about one-third of the farms of the area are operated by the owners. The large tenant class is mostly white. Cotton and corn are the principal crops, but the success of some farmers with alfalfa will no doubt make it a very important crop on the black prairie soil within a few years. But little fruit is grown and very little milk and butter are produced for sale. The grades of cattle are poor, but hogs are of good breeds. Poultry and eggs are shipped in some quantity. The farm labor is mostly white and wages are good. Land ranges in value from \$10 to \$75 an acre for the black prairie to \$10 to \$30 for the sandy soils and river bottom.

The upland soils of the area have weathered from Cretaceous rocks which underlie the entire area. The more calcareous portions of the two principal formations, the Austin chalk and the Taylor formation, have produced dark-colored soils of the prairie, classed with the Houston series, while the shales and sandy clays of the same formation have produced the more sandy soils. There are also two alluvial types.

The Houston black clay is a deep black or drab black gummy, sticy clay, underlain at lower depths by the partly altered rock. A large part of the upland is prairie formed of this and related soils. When dry the soil is loamy and easily worked, but when wet it becomes so tenacious that it is almost impossible to drive over the roads. The type covers broad rolling prairies. The drainage is usually adequate, but in recent wet years crops have suffered from too much water in the soil. It is one of the most desirable soils of the area. Cotton yields as high as one bale per acre and corn 30 to 40 bushels. Alfalfa is grown with success and is the most profitable crop of the area.

The Houston loam, locally known as "gray land," is a dark-gray or brown heavy loam 9 inches deep, underlain by a drab or brown clay subsoil. Its topography is similar to that of the Houston black clay and its origin is the same. It occurs between areas of the latter type and the more sandy soils. In wet years the soil is more productive than the Houston black clay. Cotton yields three-fourths bale per acre and corn 30 to 40 bushels.

The Lamar loam is a brown or yellow loam 12 inches deep, underlain by calcareous clay of lighter color which usually contains limestone fragments and lime concretions. The type occurs on the slopes of North Sulphur creek and is hilly and broken. It is not very productive and very little is cultivated. It owes its origin to the character of the original rock and the rapid erosion of the surface.

The Franklin loam lies at the foot of the slopes covered by the Lamar loam, and is formed from the washed material. It is a brown sandy loam 10 inches deep, underlain by lighter colored sandy loam of varying texture. Although well situated it has a low agricultural value. Corn and cotton are the chief crops.

The soil of the Lufkin clay is a silty loam with fine sand to a depth of less than 6 inches. The subsoil is a characteristic mottled, compact, impervious silty clay. Both soil and subsoil run together when wet

and form an impervious mass. It occurs along stream slopes and is derived from the shales and silty clays of the Cretaceous rocks. Some good farms are found on this type of soil, but average yields are low. Cotton yields less than one-half bale per acre. The greater part of it is uncultivated, being timbered with post oak and other scrubby oaks.

The Lufkin fine sandy loam is a gray fine sandy loam 6 to 30 inches deep, underlain by a silty, compact, mottled clay subsoil similar to that of the Lufkin clay. This type occurs on the higher, more level prairies and is extensively cultivated. It is not so productive as the Houston loam which it borders in many places, but yields are good. One-third to two-thirds of a bale of cotton per acre is secured and corn yields well.

The Wabash clay is the typical black alluvial land found along streams in Houston black clay areas. It is a black clay or clay loam 12 inches deep, underlain by a dark drab clay more plastic than the soil. The land is subject to overflow and scarcely any of it is cultivated at present. It is a strong soil and makes heavy yields where it can be farmed.

The Susquehanna fine sandy loam is an unimportant type which occurs in one very small area. It is a red sandy clay loam, underlain by a red clay mottled with gray. Thin layers of sand and occasional sand mounds cover the surface. It has very little agricultural value in this area.

RIVERS AND MOUNTAINS.

East Texas is traversed by several rivers which, together with their innumerable tributaries of creeks, constitute a magnificent system of drainage. These rivers, mentioned elsewhere in this bulletin, flow in a southeasterly direction and are navigable many miles from the Gulf of Mexico, into which they empty. Before the Civil War they were much used for transportation purposes, but since the completion of the railroads through the country the rivers are only used for tugging logs to the sawmills. A much denser population than the country now affords will justify the expenditure of a sufficient amount of money to so improve them as to make them navigable for all commercial purposes.

The mountainous range through this section commences near the Trinity river in Anderson county and extends northeasterly through Cherokee and Rusk counties. They also crop out in Upshur, Morris and the western part of Cass. They are noted principally for the vast amount of iron ore which they contain and the red soil, caused by ages of corrosion of the iron in the rocks. So abundant is iron in this soil that in burning brick made of it the iron will often melt and form a great mass of iron and clay. The soil collected in the valleys between these hills is exceedingly fertile. On these hills and valleys the Elberta peach and the tomato attain their perfection. This range of mountains does not parallel the rivers but crosses them almost at right angles, thus showing that at an early period "volcanoes poured out their molten rocks over sea and lifted ground."

EAST TEXAS BOTTOM LANDS.

The bottom lands of East Texas are, as a rule, exceedingly fertile, producing corn, cotton, sugar cane, sorghum and Bermuda grass in abundance. It is easy to find land adjacent to streams which will produce 40 and 50 bushels of corn per acre and a bale of cotton, and as many as 900 gallons of ribbon cane syrup is not an uncommon crop. Those portions of bottom land subject to frequent overflows should be sodded in Bermuda grass, Bur clover and Rescue. The intrinsic value of such lands planted to these forage and grazing crops will equal the famous alfalfa lands of the West, and at the same time the banks of the streams will furnish an annual supply of timber for fuel and other purposes. The ever-running water of the streams obviates the necessity of spending a cent for providing for stock water, and the convenience and value of a well selected and properly prepared East Texas pasture for hogs, cattle, sheep and goats cannot be excelled.

These fertile bottoms are found on what is termed the inner margin of the Coastal Plain and rise from 200 to 500 feet above the level of the sea, and are generally well drained. The soil of these bottoms is a deposit of the numerous types to be found on the uplands, there being over twenty types in the average East Texas county, as given by the Soil Surveys in the few counties where surveys have been made. The bottom soils of this country, belonging as it does to the Sabine formation of the geological Eocene age, and bounded by the Trinity series on the west, are of the alluvial division and consist of a surface-soil varying from brown to nearly black, dark-gray and dark-brown; and a subsoil varying from mottled brown-yellow, yellow and gray, mottled-yellow and gray. In years when it does not overflow it is easily cultivated, and rarely suffers from drought. If this land existed in large areas not subject to overflows its value for the production of corn would be equal to the Illinois corn lands.

THE AVERAGE PRICES OF LAND IN THE VARIOUS COUNTIES THEN
ORGANIZED (1861) IN TEXAS.

The basis of a country's wealth is land. The pioneers in Texas, like all new-comers, pursued the course of least resistance, or to what appeared to them the least. They settled in East and South Texas because to them those sections offered the greatest opportunities and were easiest of access. In these sections abounded water and timber, and climatic conditions were most congenial. The Texas Almanac of 1861 gives the value of lands per acre for the year 1859, which are suggestive of the above facts. They are as follows:

Anderson	\$ 3.07
Angelina	1.75
Atascosa	1.13
Austin	4.69
Bandera	1.14
Bastrop	4.26
Bee	.67
Bell	2.17

Bexar	1.42
Blanco	1.91
Bosque	2.30
Bowie	1.63
Brazoria	5.24
Brown	.80
Burleson	3.06
Burnet	2.06
Caldwell	4.35
Calhoun	1.27
Cameron	.32
Cass	2.13
Chambers	1.68
Cherokee	2.80
Collin	4.35
Colorado	4.63
Comal	3.96
Comanche	2.23
Cooke	2.33
Coryell	2.30
Dallas	3.79
Denton	3.31
De Witt	2.81
Ellis	3.44
El Paso	4.19
Erath	2.17
Falls	3.58
Fannin	3.57
Fayette	4.23
Fort Bend	8.50
Freestone	2.79
Galveston	2.36
Gillespie	1.71
Goliad	1.73
Gonzales	3.82
Grayson	4.07
Grimes	4.00
Guadalupe	3.71
Hardin	1.94
Harris	1.63
Harrison	4.44
Hays	3.13
Henderson	1.92
Hidalgo	.22
Hill	2.56
Hopkins	2.60
Houston	1.83
Hunt	2.72
Jack	2.21
Jackson	1.95
Jasper	1.64

Jefferson	.95
Johnson	2.78
Karnes	1.81
Kaufman	2.43
Kerr	2.50
Lamar	2.58
Lampasas	2.59
Lavaca	2.50
Leon	2.18
Liberty	1.66
Limestone	3.04
Live Oak	1.00
Llano	1.02
McLennan	4.25
Madison	2.90
Mason	1.09
Matagorda	3.03
Medina	1.67
Milam	2.00
Montague	1.62
Montgomery	2.35
Nacogdoches	1.28
Navarro	2.60
Newton	1.43
Nueces	.42
Orange	1.56
Palo Pinto	2.59
Panola	2.84
Parker	2.56
Polk	2.73
Red River	3.16
Refugio	1.00
Robertson	3.62
Rusk	3.54
Sabine	.93
San Augustine	1.56
San Patricio	.69
San Saba	1.79
Shelby	1.58
Smith	4.00
Starr	.15
Tarrant	3.25
Titus	2.68
Travis	4.70
Trinity	1.73
Tyler	2.13
Upshur	2.92
Uvalde	1.38
Van Zandt	1.96
Victoria	3.18
Walker	3.42

Washington	8.84
Wise	2.22
Wharton	10.40
Williamson	2.43
Wood	2.70
Young	.56

It will be observed that the most valuable lands of that time were those of Wharton, Washington and Fort Bend, in South Texas, and that next, omitting Travis, the seat of government, was Harrison in East Texas, while the averages of Smith and Rusk, also in East Texas, were far above the average of the other counties. At that time the average price of lands in Williamson, Ellis and Dallas was less than the average of Rusk, Smith and Harrison. The above figures are profoundly interesting in view of the fact that a further investigation and comparison of the value of land in those counties will reveal a change in values in the short space of fifty-five years that is wonderful to contemplate, and which cannot be explained except on economical grounds.

The average price of land today in Dallas, Ellis and Williamson is at least \$100 per acre, while the average price in Washington, Fort Bend and Wharton, in South Texas, and the average price in Harrison, Rusk and Smith, in East Texas, remained at a standstill for thirty years, or nearly so. Long after land was selling for \$100 per acre in Dallas, Ellis and Williamson, it was selling for five, ten and fifteen in Harrison, Smith and Rusk. The tragedy of 1861-5 tells the tale and unveils the mystery. At the time of which I am writing Rusk county owned 3850 slaves; Smith, 2913, and Harrison, 7203. Dallas owned 502; Ellis, 638, and Williamson, 813. The aggregate white population of Harrison, Rusk and Smith was 26,079, while the aggregate white population of Dallas, Ellis and Williamson was 11,354.

While our civilization was of the hardy character which belongs to the wilderness, yet, when the negro was emancipated, the white man, brave and undaunted in war, skillful and ingenious in times of peace, was not inclined to wrestle with forests when millions of untouched prairie lands could be had for a trifle, and upon which herds of cattle and sheep would solve the problem of a living without labor to the owner. Hence the prairies were settled, the population of the West increased and thrived and waxed strong. The transition from a stock to a farming country came naturally, and lands that were thought to be worthless except for grazing purposes have advanced rapidly until they are now the most costly lands in Texas.

But the tide is beginning to change. It has been demonstrated that East Texas is the ideal stock farming country of the Southwest. Owing to the almost innumerable kinds of grasses and clovers which flourish here, supplemented by an inexhaustible supply of water, together with a salubrious climate for man and beast, this East Texas country will unquestionably, in the course of time, become a world-renowned stock country. There is no domestic animal which does not reach a most satisfactory development here, and Jersey cattle, hogs, sheep and goats are unexcelled in this portion of the State.

WHEAT.

It is remarkable that this product, once a staple crop in East Texas, should become obsolete. In the counties of Anderson, Cass, Cherokee, Henderson, Panola, Rusk, San Augustine, Smith, Titus, Trinity and Upshur, as given in the Texas Almanac of 1858, wheat was a staple crop, and it was grown extensively in many other East Texas counties. It was known to produce from 15 to 25 bushels per acre, but was supplanted after the war by cotton which, at the fabulous prices then given for that staple, made its production more profitable. Hence wheat was soon a forgotten crop, and the plant is a stranger to our people, thousands of farmers having never seen a stalk of that once celebrated and most highly prized crop.

At one time tobacco was rapidly forging to the front also as a staple crop. In a report by A. M. Truit, of Shelbyville, July 1, 1858, Texas Almanac for 1859, I find this important item in a list of exports from Sabine Pass: "115,800 pounds of tobacco." In the same report Mr. Truit, in noting the staple crops of Shelby county, mentions tobacco as one of them. At that time he had resided in Shelby county for twenty years and was thoroughly familiar with the agricultural conditions of that county.

During the Civil War tobacco was produced on a majority of the farms of East Texas, and considerable progress had been made in the art of curing it and preparing it for use. It is now pretty generally known that thousands of acres of land, including large areas in Nacogdoches, Houston, Anderson, Cherokee and Rusk are peculiarly adapted to the best quality of the Cuban cigar tobacco.

BERMUDA, BUR CLOVER AND RESCUE.

Bermuda grass, Bur clover and Rescue grass will eventually become the basis of the prosperity and wealth of East Texas. This fact cannot be doubted by any one who knows the value of these plants and who has watched their development in this section. Bermuda had to fight its way at every step of its advancement, the prejudice of the cotton farmer against it being unalterably stubborn and unshaken. But in spite of that prejudice it has gone from one triumph to another until it is a remarkable fact that now and then it has a friend even among the slaves of the one-crop idea. It made its appearance in this country just before or during the Civil War. From the very start it was irresistible. Every device known to the farmer was resorted to for its extermination. The negroes dreaded it almost as they would a scourge. The faster they stirred the soil the more vigorously grew and spread the Bermuda. It encroached upon field and meadow until soon large areas were abandoned, and stock turned upon it as the last desperate act of the farmer toward the destruction of an advancing foe. Horses and cattle ate it and soon grew fat, hogs thrived upon it, every animal and fowl that eats grass eats it ravenously. After more than a half century of warfare it has made friends, but so deep is the prejudice of some good men against any hindrance to the growth of cotton that they still hate it and would destroy it if possible.

Bur clover is just beginning to introduce itself in different portions

of the country. Since East Texas has begun to incorporate its county seats and prevent cows, horses, hogs, sheep and goats from running on the streets it has made wonderful progress. For about fifty years it has grown in Henderson, but not until this year (1914) have the citizens taken notice of it. Henderson has prohibited live stock from foraging on its principal streets for two or three years, and in that short time Bur clover has literally covered many alleys, spread over some of the streets, taken possession of vacant lots, and is rapidly covering an old Bermuda pasture near the city. It grows on the poorest soil, clay and sandy, and so luxuriant has it become that the most casual and indifferent observer has looked upon it with astonishment, and many, no doubt, with fear and dread, believing that it may, like Bermuda, be an enemy to cotton. It seems to thrive best on the Bermuda soil. In places the vines are nearly or quite three feet in length.

Rescue has had to fight the town cow also for about the same period that Bur clover has, and has only attracted the public eye since that animal was forbidden to find her living on the streets and alleys.

Dr. O. M. Ball, Professor of Biology in the Agricultural and Mechanical College of Texas, has written an interesting book on "Farm Seeds and Plants," from which I take the liberty of copying what he says about Bur clover, Bermuda and Rescue grasses, as follows:

"Bur clover (*Medicago denticulata*), like the Japan clover, is of incalculable value to farmers in the southern parts of the Gulf and Atlantic States. A very nearly related and quite as important species is the spotted Bur clover (*Medicago maculata*). The latter is recommended especially for the light and sandy soils of the pine lands. Both species are sensitive to frost and will be killed by temperatures of 23 or 24 degrees, though suffering but little injury from light frosts.

"Common Bur clover, is an annual, recumbent, or, when crowded, more or less erect, sometimes creeping, much branched plant. The leaves are trifoliate and the leaflets ovate or obovate, with denticulate margins. The flowers are yellow and are not collected in heads. The seeds are borne in twisted pods, there being one or two turns in each pod. The seeds are kidney shaped, light yellow or brown, somewhat larger than and strongly resembling alfalfa seed, which they have frequently been used to adulterate. The plant is said to be a native of the west coast of South America and to have been introduced into Europe by means of the burs clinging to wool exported from that country. The thrifty Germans are said to have threshed the burs, after carding them from the wool, and to have used the seed to adulterate alfalfa. It is found in the summer around seaport towns of the Atlantic coast, but in the Gulf States has become a winter plant, springing up after the fall rains have set in, from the latter part of October to the middle of December, according to the season. It makes a vigorous growth throughout the winter and dies completely away in May or June, but leaves an abundance of seed in the soil. This habit makes Bur clover one of the most important cover and winter forage crops of this section. It grows well in almost all soils but apparently does best on not too fertile uplands. The plant requires considerable water and will not appear in seasons of scanty rainfall. It is also quite sensitive to cold and to very hot weather, being killed by heavy frosts, though

in almost all cases a second crop will spring up after the frost. Careful experimentation and selection would no doubt lead to the discovery of more resistant varieties, but as yet nothing has been done along this line.

"Bur clover grows admirably in a sod of Bermuda grass and this combination is unexcelled for regions adapted to both plants. So far as has been observed, the clover is not disturbed by the grass, while the latter is greatly benefited by the supply of nitrogen fixed by the former, which, indeed, is one of the best for this purpose, in the regions mentioned. The plant responds readily to application of barnyard manure. When growing in Bermuda sod, both plants are greatly benefited by occasional stirring of the soil with the disc harrow or with a light plow. This is best done in the spring after the Bur clover has seeded and before the rains have ended.

"Live stock of all kinds will quickly learn to eat bur clover. For best results as a green forage crop it should be rather heavily pastured throughout the season, since all kinds of stock eat it better when the plants are small. It is especially relished by dairy cows in the early spring when but little else is green.

"The seed should be sown at the rate of from ten to fifteen pounds per acre on well prepared land; in this section at any time from the first of October until the middle of December, according to the season. Under ordinary conditions in the milder parts of the gulf region, the plant will reseed each year so that the stand will be permanent. For these sections no better restorer of the soil is known."

"In the Southern States but few grasses are sown for pasture, the principal ones being Bermuda grass, Texas blue grass and Kentucky blue grass. Of these, Bermuda grass is by far the most important. It is believed to have made its appearance in this country in Georgia during the war of 1812 and is said to have sprung up from grass wrappings of crockery ware which had been thrown out into the street by a merchant of Greensboro in that State. Just why it should have been called by the name now commonly given it is not apparent, for there is no evidence to show that it came from Bermuda. The grass has since spread northward to the Mason and Dixon line and westward to the Pacific coast and is as common throughout the South as blue grass in the North. It is peculiarly adapted to southern climates and thrives in the hottest weather of summer. It does not like shade but prefers full exposure to the sun's rays. It is remarkably drought resistant and is not harmed by prolonged dry weather in Central and Southern Texas, but is not equal to the very dry climate of the western parts. It is quite hardy and is not affected by the cold of winter even in Virginia and Maryland.

"Bermuda grass will grow on practically any soil in the South. In the moister regions it thrives on almost pure sand and it flourishes in the richest soils of the river bottoms. It is not harmed by overflow and is the best grass known for holding river banks and levees. When well established it forms a dense, tough sod which remains permanent for many years. On account of these habits, the grass is difficult to eradicate from fields where it is not wanted, though as one farmer said, 'Nobody ought to want to get rid of Bermuda grass.' On irrigated

lands, however, it has become a serious nuisance and is even more to be dreaded than Johnson grass. It does not form a deeply growing root stock like Johnson grass but spreads by long creeping stems that root at intervals and it produces no seed except in the southern parts of Florida, New Mexico and California. Consequently it is not difficult to confine the plant to limited areas. It can be killed out completely by a single deep plowing during hot and dry summer weather or just before a freeze in winter. Professor Dodson of the Louisiana Experiment Station says that it can also be killed in one season by plowing the land deeply in December and in the following spring sowing to Velvet beans or cowpeas.

"The grass is generally started by planting pieces of the sod. Good seed are very scarce and expensive, practically all of the Bermuda grass seed sold in this country being imported from Australia. The seed may be sown at the rate of three or four pounds per acre on prepared land at any time when the ground is moist.

"Bermuda is first of all a pasture grass but on rich, alluvial bottoms may grow tall enough to cut for hay. For best results as pasture it should be grazed closely and systematically, since live stock do not readily eat the coarse and old stems. Good Bermuda pasture will easily support two head of cattle to the acre throughout the season. The writer has for ten years kept a driving horse on a pasture of less than two acres, at an expense for grain of less than two dollars per month. In the early spring he pastures his neighbor's cow gratis, in order to keep the grass down. The farm stables charge \$9 per month for board for a horse. At this rate the value of the grass is something like \$3.50 an acre per month. This pasture, however, is a very fine mixture of Bermuda and Bur clover, and has been cultivated twice during the ten years. The land without the grass is not worth more than \$10 an acre. Thirty head of cattle of different ages were kept on seventeen acres of Bermuda pasture at the Louisiana Experiment Station, with no other feed, from March 25th to November 1st, and in addition sixteen steers were run on for a few weeks when the growth was most vigorous. It is stated by Professor Killebrew of Tennessee that an acre of good Bermuda grass will keep ten sheep in good condition for eight months of the year.

"The great possibilities of Bermuda grass in combination with some legume such as Bur clover or hairy vetch as a permanent and profitable solution of the one-crop system of farming that is so detrimental to the South do not seem to have been properly appreciated in this region. There can be but little doubt that live stock may be grown in any of the Southern States as profitably on Bermuda grass as on Kentucky blue grass in other sections."

"Rescue grass (*Bromus unioloides*) is an annual plant, growing wild in Central and South Texas, where it is an important addition to the winter pasture, if supplied with sufficient moisture. It appears late in the fall and matures its seed in May and June, thereby escaping the dry weather of summer. Stock of all kinds will eat it readily and when the rainfall is sufficient two or more cuttings of hay may be made in one season on soils sufficiently fertile. Rescue grass makes a close and rather handsome growth, from two to three feet in height. It reseeds

itself every year but should not be pastured too late in spring, else the seed crop will be lost. For best results, either for hay or pasture, the soil should be disced or harrowed early in the fall before the seed sprouts.

"The seed should be sown at the rate of four to six pecks per acre on land that has been put into good condition and is free from weeds. The best time to sow is just before the fall rains set in, or from the first of October on. Bur clover or some other legume should be sown with Rescue grass, though on fertile lands and under best conditions the grass is apt to crowd the legume to the wall."

THE RICE BELT.

Between the Long Leaf Pine Belt and the Gulf of Mexico is the famous rice district. This district is known as the Coastal Plain, and is made up of all the different kinds of soils drained by the rivers passing through it. In a bulletin published by the Department of Agriculture entitled "Soils of the United States," in a description of this district, it is said:

"The soils are for the most part composed of sands and light sandy loams, with occasional deposits of silts and heavy clays. The heavy clays are found principally near the inner margin of the Coastal Plain. The silts, clays and black calcareous soils, upon which the rice and sugar cane industries of Southern Louisiana and Texas are being so extensively developed, have no equivalents in the Atlantic division."

For the year 1909 Texas had 237,586 acres in rice, 106,920 acres of which were in Jefferson, Liberty, Orange and Chambers, Jefferson alone containing 56,321 acres. That year the average production per acre was 37.8 bushels. The yield in Jefferson was nearly 40 bushels per acre. Jefferson is not only the banner rice-producing county of the State, but excels in the production of oil.

The per cent of increase in acres, in the production in rice, in Texas, from 1899 to 1909, was 2627.4, which is larger than the increase in acres of Kaffir corn and milo maize in the Panhandle.

SHOULD BE CLASSED AS EAST TEXAS.

The counties of Freestone, Leon, Madison, Walker and Montgomery topographically belong to East Texas. They are situated immediately west of the Trinity river, and were originally covered with a heavy growth of timber, the pine forests having extended north into Leon. The Trinity river and its tributaries furnish an abundance of water. The soil of the uplands is a deep, sandy loam, and in the bottoms a very rich alluvial soil prevails. In the Trinity river bottom, however, the land is a black sticky soil and very fertile. It is the washings of centuries from the fertile black prairie belt above, and at some future time, when the waters of the Trinity will be confined to the channel by a system of levies, its value will surpass all other lands of the State.

Walker county attained a conspicuous place in the progress of Texas before the Civil War. Huntsville, the county seat, was the site of Austin College and Andrew Female Institute; the former was under the supervision of the Presbyterian Church and the latter under the

Methodist Church, and both were in a "flourishing condition" prior to 1858. Sam Houston, and Yoakum, the historian, lived in Huntsville, that being their last abiding place on earth. The first State Normal School was established there, and is now one of the best equipped institutions of its kind in the Southwest. This section of Texas is, in many ways, peculiarly situated. The winters are very mild, the northers being less severe than they are in the counties to the northwest, owing to the protection of the timber and the nearness of the warm Gulf stream. The summers are made pleasant by the almost constant Gulf breeze.

THE LONG LEAF PINE BELT.

The Gulf Coastal Plain, extending from the Gulf of Mexico from thirty to forty miles north, reaches the Long Leaf Pine Belt, which is one of the most remarkable forests of the world. This belt extends from the Trinity river east, far into the State of Louisiana. Governor Roberts says this belt consists of an area equal to eighty or a hundred miles equare. Dr. Frederic William Simonds, in his *Geography of Texas*, says this area is equal to about 2,890,000 acres.

It must be remembered that this area is not one dense, solid forest of long leaf pine. The country is almost level, with what are termed swells occurring throughout the area, and upon these swells, which are slight elevations, the long leaf pine is found. Between these swells are wide flats, often covered with dense thickets, intermixed with evergreens, such as holly, magnolia, privet, and many varieties of the hawthorn. The Angelina river runs almost through the center of this belt, and since the Sabine is the line on the east and the Trinity on the west, with their numerous tributaries, it can readily be understood that an abundance of water exists for all purposes. The bottom lands of these streams, which are very little lower than the pine lands, abound in various kinds of hardwood, such as white-oak, pin-oak, beech, elm, ash and hickory. Originally, there were dense forests of cypress on the swamp lands near these streams. As a rule, the bottom lands are very fertile, though requiring considerable labor to prepare them for cultivation.

The Long Leaf Pine Belt includes Hardin, Jasper, Newton, Polk, Trinity, Tyler, the northern part of Orange, and Jefferson and the southern portions of Sabine, San Augustine and Angelina counties. The oldest settled portion of this belt dates as far back as 1830, in Jasper county, which at that time was a veritable wilderness, as wild as the jungles of Africa, yet free from the ravages of Indians or the forages of Mexicans. The early settlers of that section had nothing to fear from wild life except the bear and panther. They together with other wild animals roamed the forests by day and by night, unmolested and in numbers so vast that no one could estimate them. Originally Jasper and Newton were one county and were divided when the counties were reorganized under the State Constitution of 1845. At first, however, it was a municipality of Nacogdoches, and in 1834 it was created into a separate municipality by the name of the Municipality of Bevil, with the town of Jasper as the seat of the Municipality, located under the authority of George Antonio Nixon, Commissioner of Zavala's colony.

Hon. George W. Smyth, writing of Jasper and its people, about 1858, says: "I take pleasure in bearing my testimony to the integrity—the great moral worth—of these early pioneers, a very few of whom I have mentioned. Rarely, if ever, have I found among an equal number of persons a greater amount of all that is most valuable in the American character." Mr. Smith had an acquaintance with the people of that section as far back as 1830. It can be said of that particular section, which cannot be said of any other in East Texas, that it was ever exempt from feuds, so common elsewhere, that the peaceful pursuits employed the time and talents of its people, and neighborhoods were bound together by the ties of genuine fraternity.

From the beginning of the settlement of this section up to the present time it has maintained the largest per cent of pure Anglo-Saxon blood among its population of any other section of the same size in the United States.

The first settlers selected the most favored spots—places where the land was rolling and pines were absent. Woodville, the county seat of Tyler county, was built in "the midst of a grove of magnolia trees." Livingston, the county seat of Polk county, was noted for its schools and churches before the Civil War, and an abundance of peaches were produced there sixty years ago. It should be stated that in all the well drained country the Long Leaf Pine Belt peaches were cultivated with wonderful success long before the Civil War.

"THE CUT OVER LANDS."

The cut over lands of this section are beginning to attract marked attention. As stated elsewhere, the pioneers selected the most desirable spots, and left the great forests entirely alone. The long leaf pine forests had no value. The land upon which they grew was thought to be almost worthless, and as there was no demand for lumber and no way to create any demand for it, the dismal solitude of the thick, tall pines reigned supreme until a few decades ago. Railroads first penetrated the wilderness, sawmills came as a matter of course, and trams from the trunk lines reached out gradually, bringing in the logs as fast as the mills could cut them into lumber. Forest after forest melted away, new mills came, and soon millions of dollars were invested in machinery until the great belt reaching from the Trinity to the Sabine, and from Orange to Lufkin, the busy hum of the ravenous steel teeth never ceased day or night. And now the scene is beginning to change again. Hundreds of thousands of acres, bereft of their huge forests, will in the next decade assume an entirely different aspect. The homeseeker will not very long defer the last opportunity in Texas to avail himself of a cheap home.

Mr. T. O. Walton, Agricultural Agent, appointed by the Department of Agriculture of Washington, D. C., in reply to an inquiry from the writer with reference to the "cut over lands" of the Long Leaf Pine Belt, says:

"LIVINGSTON, TEXAS, May 9, 1914.

"DEAR COLONEL MILNER: Beginning with Polk, I believe the following will be an approximate of the lands cut over in the Long Leaf

Pine Belt: Polk, 75 per cent; Trinity, 60 per cent; Angelina, 60 per cent; Tyler, 72 per cent; Hardin, 85 per cent; Jasper, 82 per cent; Sabine, 70 per cent; Newton, 75 per cent; Orange, 90 per cent; Jefferson, 95 per cent. These estimates are based upon my travel and observations in these counties.

"These lands will produce corn, cotton, peas, peanuts, potatoes, grain, sorghums, and the lands of lower Jasper, Newton and those counties are especially well adapted to the growth of sugar cane. As to their fertility, this varies in a very marked degree; however, I would say that the average long leaf piney lands are principally sand, and that they will compare in production, very favorably, with the *very deep sandy soils* of your county (Rusk). Some of these soils, however, have a very good subsoil and can be made to produce great crops. Their yield per acre of corn or cotton would be from one-fourth to one-half bale of cotton per acre, and from 15 to 25 bushels of corn. This is in their virgin state, and without fertilizers.

"Prices on that part of the cut over lands that are on the market will range from \$5 to \$15 per acre, depending upon distance from market, grade of land and acreage purchased. If bought in large tracts, it could likely be bought as low as \$5 per acre.

"At this time the timber is being cut slowly and most of the timber is held by very large lumbermen, so it will probably be twenty-five years before all the present supply of these mills is exhausted.

"These lands are well supplied with springs and clear running creeks, and health will be good if water supply is kept pure and flies and mosquitoes are avoided.

"In a general way the lands you inquire about are not considered to be very good, yet if you will use care in the selection of these lands, and get where you have a good subsoil, I consider them the best *cheap* lands in Texas today.

"Yours very truly,

"T. O. WALTON."

By reference to the map of Texas, it will be observed that this Long Leaf Pine Belt is luckily situated in many ways. Bordering on the Gulf of Mexico, far from the prairies, it escapes the northers of winter, and the long summers are modified by the Gulf breeze. Beaumont is a city of more than twenty thousand population; Port Arthur and Orange are in a navigation district which has advantages superior to any other district on the Gulf. Beaumont is situated on the Neches river, fifty miles from Sabine Pass. The Neches is one of the best rivers in Texas and passes through the center of the Long Leaf Pine Belt. Orange is a good town situated on the Sabine river about thirty miles from the Gulf of Mexico. The Sabine river forms the eastern boundary line between Texas and Louisiana, and is, of course, the east line of the Long Leaf Pine Belt in Texas. Port Arthur is nearly thirteen miles from the bar at Sabine Pass, and the government has already spent \$4,000,000 in building the canal and otherwise improving the harbor at that place. Last year the total commerce of Port Arthur amounted to nearly fifty millions of dollars. Its exports consisted principally of grain, cotton seed meal and cake, sulphur, oil and oil products, logs and lumber. The Neches and Sabine were the only means of

transportation prior to the building of railroads, which now traverse every county in the Long Leaf Pine Belt. Near this belt are the cities of Galveston and Houston. Galveston is already the largest cotton exporting city in the world, having received last year over 4,000,000 bales and exported to foreign countries 3,876,936 bales. It also exports vast quantities of cotton seed meal and cake, lumber, logs, wheat, corn, packing house products and staves. Houston, which is almost adjacent to the southwestern corner of this belt, is destined, in my opinion, to become, during the next fifty years, the largest and most prosperous city of the Great Southwest. Its growth and commercial importance are attracting the attention of prospectors and investors from all parts of the United States and from foreign countries. Hence the facilities already exist for handling, marketing and exporting the products of this belt, and as the cities mentioned turn their attention more and more to manufacturing enterprises the demand will increase for the innumerable horticultural products for which the Long Leaf Pine Belt is particularly adapted.

Besides these facilities it has churches and schools throughout the large area, and many of the county seats are noted for a large degree of interest now manifested in every movement which represents a higher standard of intelligence, prosperity and morality.

The country was originally settled by people representing the pure Anglo-Saxon race from the Southern States east of the Mississippi river. No foreigners and very few negroes ever lived in that section. In 1858 the total number of negroes rendered for taxation in the counties of Polk, Jasper, Liberty, Jefferson, Newton, Orange, Sabine and Tyler amounted to 5904, over 1200 less than Harrison county possessed.

A county abounding in innumerable springs, clear running streams, timber for all practical purposes, which ages will not exhaust, a climate free from the cold blasts of winter and cooled by the Gulf breeze in the summer, traversed by railroads, a soil capable of producing all vegetables peculiar to any part of the world north of the tropics, and many of the fruits, also a large variety of field crops, right in the lap of a civilization which has existed since 1836, with millions of acres of land which can be purchased for less than \$10 per acre on easy terms—a country like that ought to interest a large number of the millions of good farm tenants scattered throughout the land who would like to have homes.

NEGLECTED AND OVERLOOKED.

This neglected and overlooked section of Texas has furnished more wealth, by far, than any other area of the same size in the Southwest. Hundreds of millions of dollars worth of oil have been taken from the earth, and as many more, perhaps, from the forests, and the streams continue to flow. No telling how long the oil will last, and the timber is sure to hold out for about another quarter of a century. Besides these, iron ore abounds in quantities so great that in the absence of the estimates of geologists I would not hazard a guess. But it is as a farming country that East Texas is to bestow its greatest blessing upon humanity. Not since the country was settled has there been a failure of all crops. There are so many types of soil, adapted to so great a variety of plants, that though a few may once in a while fail, owing to ex-

cessive moisture, or a drought, others will succeed. It has been stated by all observers of East Texas that the farmer can live better and cheaper here than in any other section, because of the cheapness of the land and the ease with which he can grow nearly all the necessities, and, you might add, all the luxuries. The poorest East Texas uplands will grow fruits and berries, and on the same lands all kinds of domestic fowls can be cheaply raised, a Jersey cow supported, and many varieties of fruits grown; and with all these, with the addition of sugar and coffee, a luxurious living has been supplied. The home devices for canning fruits and vegetables, without any expense almost, enable the farmers to supply themselves permanently with these luxuries. But no one should entertain the notion that success is attained in East Texas without effort and good management. This is shown in the squalid condition of some and the prosperous circumstances of others.

RAINFALL AND TEMPERATURE.

Below is given a record of the rainfall of Longview, Gregg county; Palestine, Anderson county, and Nacogdoches, Nacogdoches county, for a number of years; also the temperature of the same places for a period of years. The situation of these places is such as will fairly represent all of East Texas.

Nacogdoches, Nacogdoches County (Elevation 271 Feet).

Year—	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	1.76	3.99	3.78	4.39	4.65	3.51	1.82	3.41	1.18	1.70	7.10	4.30	41.59
1900	4.70	1.16	6.44	7.00	8.13	6.59	3.72	3.28	3.77	4.04	6.54	1.67	57.04
1901	1.83	5.14	3.51	5.79	2.25	5.41	4.62	2.18	5.17	4.50	2.59	2.19	45.18
1902	2.51	3.60	5.21	2.91	4.54	14.22	5.77	0.48	10.03	5.57	6.19	2.04	63.07
1903	4.86	6.70	5.05	1.23	2.98	2.99	7.52	3.01	0.15	5.98	0.37	5.17	46.01
1904	1.86	3.86	3.23	4.41	2.71	4.06	5.54	3.56	4.68	0.33	0.88	8.03	43.15
1905	3.19	3.98	5.62	8.88	8.99	5.21	9.43	3.69	2.74	1.78	10.16	5.86	69.53
1906	4.85	1.73	1.63	4.26	1.54	4.65	7.91	1.68	1.74	4.12	1.91	3.60	39.62
1907	2.96	2.84	2.15	4.65	9.07	0.21	2.33	0.15	0.63	6.44	10.39	4.55	46.37
1908	2.31	6.37	3.40	4.12	6.87	0.92	2.46	3.92	5.59	0.12	2.98	1.56	40.62
1909	0.44	3.24	2.01	3.93	4.79	3.90	4.33	1.15	1.23	2.89	0.85	8.40	37.16
1910	1.56	9.76	0.89	4.22	8.52	4.92	2.14	1.84	0.94	2.27	3.41		
1911	Tr.	2.93	3.89	9.62	0.61	0.52	11.17	2.09	0.53	1.84	5.00	10.51	48.71
1912	1.96	3.57	7.18	7.46	9.44	4.66	0.64	2.30	Tr.	0.91	0.80	6.49	45.41
1913	4.04	3.98	4.63	4.42	5.01	1.61	0.81	0.68	11.87				

Longview, Gregg County (Elevation 336 Feet).

Year—	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1893	0.38	1.82	2.88	1.67	6.67	2.64	0.90	3.81	4.20	1.46	6.42	2.62	35.47
1894	4.44	3.40	7.07	4.25	1.24	2.62	5.50	6.34	2.06	0.21	1.60	3.66	42.39
1895	7.44	1.84	3.92	1.49	8.09	10.76	5.70	1.43	0.01	3.59	2.66	3.26	50.19
1896	8.18	5.22	2.82	2.09	2.42	3.41	3.73	1.08	3.30	6.66	2.15	2.55	43.66
1897	5.19	0.20	10.31	4.61	6.76	3.89	3.03	1.70	2.16	2.39	1.93	7.02	49.29
1898	9.42	2.86	3.30	1.24	1.69	5.21	1.17	3.01	3.77	1.94	3.60	2.55	39.76
1899	4.09	1.40	1.64	5.69	6.87	4.94	1.81	0.83	0.43	5.60	1.86	4.20	39.36
1900	3.39	3.05	7.37	6.60	5.98	3.27	3.13	1.28	5.01	3.78	1.48	2.01	46.35
1901	3.30	4.01	4.00	3.52	5.55	1.97	3.55	1.47	6.12	3.74	4.84	2.79	44.86
1902	2.52	2.63	3.59	3.44	2.03	4.50	7.83	0.09	5.05	2.53	10.71	4.00	48.92
1903	1.12	9.34	3.62	0.52	3.57	3.80	5.90	2.18	1.14	3.19	0.65	2.73	37.76
1904	0.47	2.92	2.04	6.23	4.82	6.55	4.67	2.28	2.37	0.22	2.30	5.80	40.67
1905	4.04	2.33	6.00	8.00	7.59	8.51	8.03	0.40	2.08	1.80	5.56	8.96	63.30
1906	2.52	2.28	7.91	1.51	3.44	3.60	5.88	5.17	3.47	4.23	1.34	7.03	48.38
1907	2.23	2.67	4.10	5.71	7.59	0.68	2.68	1.15	0.13	4.09	10.89	3.67	45.59
1908	2.57	5.79	2.62	4.96	10.30	2.05	2.46	3.52	3.86	0.14	1.91	3.02	42.20
1909	0.45	3.74	3.78	2.49	1.85	2.41	1.45	2.15	1.46	3.25	2.30	7.38	32.11
1910	1.76	3.99	1.67	4.89	5.93	1.89	2.41	0.72	0.71	1.09	1.88	5.17	32.11
1911	0.45	6.13	2.22	7.96	1.77	0.42	6.08	5.90	0.55	1.60	2.92	6.35	42.35
1912	2.31	2.03	8.08	6.57	2.02	4.35	2.11	15.28	0.26	0.81	1.26	4.32	49.40
1913	2.83	4.16	4.93	4.56	2.75	2.89	3.32	0.22	11.96				

Palestine, Anderson County (Elevation 510 Feet).

Year—	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1893.....	1.14	1.25	2.67	3.37	4.96	5.35	0.09	3.55	1.32	0.17	4.94	1.77	30.58
1894.....	2.28	3.68	4.59	6.47	1.83	4.03	2.76	5.45	10.04	1.04	1.90	1.98	46.05
1895.....	2.42	2.50	2.52	2.35	11.38	5.29	3.85	0.06	1.05	3.73	4.23	4.34	43.72
1896.....	7.67	7.05	1.77	1.22	4.13	0.71	1.67	1.19	2.01	7.16	1.67	2.15	38.40
1897.....	5.95	0.29	8.19	2.01	4.27	4.16	1.01	0.48	1.36	3.65	1.30	6.81	39.48
1898.....	7.70	4.68	2.24	1.43	3.24	5.50	2.29	3.22	1.92	2.42	4.19	5.22	42.05
1899.....	5.48	3.46	1.43	2.81	4.84	8.66	4.52	1.83	0.28	7.18	2.71	4.51	47.71
1900.....	4.70	1.16	6.44	7.00	4.63	2.55	2.85	3.29	3.77	3.02	3.18	1.73	44.32
1901.....	3.14	2.85	2.91	4.97	2.92	1.96	0.78	3.45	10.57	2.70	2.54	2.43	41.22
1902.....	1.56	1.83	3.31	2.13	2.02	1.57	10.03	Tr.	5.14	3.42	7.08	1.67	39.76
1903.....	2.96	5.97	4.66	0.80	1.80	4.19	8.76	1.56	2.45	4.90	0.01	1.33	39.48
1904.....	0.66	3.50	0.88	5.02	3.97	4.73	2.52	1.58	4.08	0.68	0.67	4.08	32.37
1905.....	2.06	2.47	3.95	6.51	6.79	5.43	4.87	0.72	0.59	3.47	4.56	4.88	46.30
1906.....	1.92	3.06	1.24	2.47	2.62	3.49	2.58	1.43	3.14	3.93	1.66	5.40	32.94
1907.....	1.13	1.51	2.01	3.68	5.74	1.39	0.80	0.29	2.91	5.32	10.07	3.16	38.01
1908.....	1.74	4.45	2.24	5.13	7.86	2.22	1.17	2.69	2.32	1.15	1.07	1.75	33.79
1909.....	0.19	3.66	2.27	2.51	0.98	3.36	0.80	2.11	1.55	2.74	1.51	2.40	23.98
1910.....	0.48	3.18	1.92	3.64	5.75	1.49	1.75	0.96	1.13	1.06	1.92	3.23	26.51
1911.....	0.48	3.16	4.65	8.24	0.77	0.55	3.72	3.01	0.59	3.04	2.35	6.68	37.24
1912.....	0.14	1.54	7.55	4.43	2.73	3.69	0.61	0.46	1.66	2.69	0.57	4.77	30.84
1913.....	3.45	3.57	2.69	3.30	2.83	1.51	0.71	0.23	6.64				

Following is the record of temperature at Longview (twenty-eight years), Nacogdoches (ten years), and Palestine (twenty-nine years). It will be noticed that the temperature is practically the same at each of these stations, and that the absence of extremes is a marked feature. At few places in the United States can there be found a greater uniformity of climate most desired by the various conditions of mankind.

MEAN TEMPERATURES.

Stations—	No. yrs record.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Longview.....	28	47.3	49.1	58.2	65.4	73.9	81.1	83.6	83.4	77.5	66.1	56.2	48.6	65.9
Nacogdoches.....	10	47.4	51.0	60.4	65.2	72.1	78.9	80.8	81.9	76.0	66.0	58.4	48.3	65.5
Palestine.....	29	47.6	50.8	59.1	66.2	72.2	78.7	81.4	81.4	76.5	67.1	57.7	50.0	65.7

APPENDIX.

EXTRACT FROM A LETTER OF JUDGE NORMAN G. KITTRELL; ALSO LETTERS FROM PROFESSORS H. NESS, E. J. KYLE AND J. C. BURNS OF THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.

Professor Ness is Horticulturist in the Experiment Department, Professor Kyle is Dean of the School of Agriculture and Professor of Horticulture, and Professor Burns is Professor of Animal Husbandry and head of that Department. Judge Kittrell was raised in East Texas, and was district judge for many years of an East Texas district.

Judge Kittrell's letter:

I put the following thirty counties in a group and denominate them East Texas: Anderson, Angelina, Cherokee, Freestone, Gregg, Grimes, Hardin, Henderson, Houston, Jasper, Leon, Liberty, Madison, Montgomery, Nacogdoches, Panola, Polk, Robertson, Rusk, Sabine, Shelby, Smith, San Augustine, San Jacinto, Trinity, Tyler, Upshur, Van Zandt, Walker and Wood. I name them alphabetically, not geographically. You will observe that none of them cross the H. & T. C. R. R., and none touch the coast, and that on the west or southwest the line stops on the north line of Harris county. The area is 25,500 square miles. I will proceed to show you that these counties have practically stood still as to population, while people seeking homes have gone elsewhere.

These thirty counties contained, in 1900, a population of 537,594, and in 1910 a population of 588,430, an increase of only 49,364, or a fraction over 9 per cent for the entire decade.

The population per square mile is slightly in excess of 23.

Eighteen counties within 100 miles of Dallas, including that county, contained, in 1900, a population of 722,674, and in 1910 a population of 899,209, an increase of 176,535, or nearly 25 per cent for the decade.

Eighteen counties lying northwest of Dallas, commonly known as the Panhandle, had, in 1890, a population of 17,666, and in 1910 a population of 62,949, an increase of 45,283, or about 259 per cent.

These figures show that East Texas increased less than 1 per cent per annum in population during the last census decade, and has 23 population to the square mile, against 400 in New England. Now, you know, as well as I do, that taking it year in and year out East Texas will produce more surely a greater variety of those products used to feed and clothe the human race than any other territory of like area in the world. Then why does it stand still? It is because all over it—in Rusk county as in all the rest—far the largest part of the well-established farms were cleared by slave labor, and because the average white small farmer will not, if he can, find prairie land, cut down trees, pull out roots and dig stumps. He had rather dig out a sodhouse, take a coil of barbed wire and a few mesquite and cottonwood posts and begin on the prairie,

and the result has been that the increase of population has not even been normal. Far more people have left than have come on and been born put together. People who don't know East Texas, and their name is legion, will say it is because nothing can be raised there.

Let us see as to that:

The cotton production in Texas in 1910 was an average per county of 12,396. The average of the thirty East Texas counties was 12,768, or 372 bales above the average. The production per capita of population was slightly in excess of three-fourths of a bale (1200 pounds) of seed cotton, including the black lands and river lands held at from \$50 to \$100 an acre. The production per capita of the thirty East Texas counties was a slight fraction less than two-thirds of a bale (1066 pounds) on land held at from \$5 to \$25 per acre.

The thirteen cotton-farming States produced, in 1910-11, 13,617,409 bales. Had they produced in the same ratio that the thirty East Texas counties did, they would have produced 18,000,000 bales.

The thirty East Texas counties contain approximately $9\frac{1}{2}$ per cent of the area of the State. They produced slightly in excess of $12\frac{1}{2}$ per cent of the cotton crop of the State, besides corn, cotton, sorghum, sugar cane, milo maize, pumpkins, sweet potatoes, Irish potatoes, peanuts, broom corn, watermelons, cantaloupes, peas, blackberries, dewberries, strawberries, and more vegetables with less work than any other nation in the world.

Official figures furnished me by the freight departments of four lines of railroad show that from not exceeding fifteen counties of East Texas, mostly from eight, there were shipped, in the season of 1912, 6976 carloads of peaches and vegetables, over 4500 being peaches. Tied together, they would make a train forty-six miles long. In the week ending July 27 Henderson county shipped 1269 carloads of peaches, and that is a "poor" East Texas county.

The longitudinal and latitudinal location of East Texas, its temperature, soil and climate combine to enable it to produce more varieties of the fruits of the earth than any other land under heaven. This is as true as Holy Writ. Yet she has only 23 people to the square mile, against 53 in North Texas, and only \$7,351,604 of taxable values per county, against \$31,816,704 in North Texas. However, while taxable values in North Texas increased in 1911 over 1910 only $1\frac{3}{8}$ per cent, those of East Texas increased nearly $12\frac{1}{4}$ per cent. In 1913 the increase in North Texas was about 6 per cent, while in East Texas it was approximately 10 per cent. The thirty counties increased in taxable values in 1913 nearly \$19,000,000.

The average (mean) temperature of East Texas, taken at Palestine, was for thirty-three years 65.5. The thirty counties contain in acres 16,320,000.

The 1910 census lists lands as "improved farms and unimproved lands in farm." I take it "improved" means farms enclosed and in actual cultivation, as distinguished from enclosed lands not cultivated, and the whole is given as 3,442,116 acres. This leaves of land enclosed but not actually subjected to cultivation, and virgin land, or land wholly unimproved, 12,827,884 acres, or a fraction over 20,000 square miles, an area larger than that of several New England States combined.

With these conditions existing, 100,000 people left the United States for Canada in a single year, and fifty carloads passed through here (Houston) in one day on their way to the Rio Grande Valley to pay \$100 an acre for land. While the Canadian works six months to get food and fuel while he is frozen up the next six, and at the same time hundreds of East Texas children never saw snow.

The one remedy and the only natural way to settle East Texas is to buy the lands and settle them, not with foreigners, but with native-born, red-blooded Americans. Not the kind of which there are far too many now, who begin to work in March and quit and go fishing in July, and who live and plow and plant "like daddy did," but men who will farm with their brains, and have a garden in September, just as they had in May, and who have sense enough to know that it costs no more to keep a Jersey cow that will give three gallons of milk a day than it does to keep a scrub that will give a quart, and that he can keep a Berkshire for half he can keep a razorback that he has to tie knots in the tail of to keep him from getting through the cracks of the fence.

The man who has not a home and farm had best get one and do it quick. The cause of the cry about high cost of living is too many eaters and not enough producers. There must be more land put to the plow. East Texas has the last 13,000,000 acres of cheap land in a temperate climate in all the South. She is going to arrive into her own and that very soon.

NORMAN G. KITTRELL.

Professor Ness' letter:

COLLEGE STATION, TEXAS, April 22, 1914.

Hon. R. T. Milner, Henderson, Texas.

MY DEAR MR. MILNER: I am glad to embrace this opportunity of giving you my impression of East Texas, where not many years ago I was a farmer. I selected my farm in Rusk county as the locality where industry, added to a small capital, seemed to give assurance of a safe and independent home.

It was not without regret that I sold my little farm; but I knew that, even with good renters on it, the improvements which I had made during my four years' stay must be stopped and deterioration take its place. Just that consideration made me sell the farm, for I was well aware of what work it would be to rebuild houses, fences and fertility after a few years of renting out the place, myself living in the meanwhile at a distance of two hundred miles.

In traveling over the State, which I sometimes have occasion to do, and frequently into parts where newcomers are settling, or where all is done to induce them to settle, I cannot but notice how much higher prices, greater number of hardships and inconveniences they encounter than I did in East Texas. Fence timber I found conveniently and in abundance on the place; a well fourteen feet deep, with most excellent water, was found at the back porch of my new-built house; clear flowing water from springs in a place most suitable for cattle pasture, and in another place near my barn suitable hog pasture. These were inconveniences that came gratis.

My place contained only seventy-five acres and was not exceptional in these advantages; they were common on every farm.

The soils of Rusk county and a large part of East Texas are mostly made up of the Norfolk and the Orangeburg series of soils. These are red sandy loams or red clayey loams of excellent mechanical texture and fertility. When freshly cleared from the forest, owing to the ready decomposition of the organic matter in these soils, crops of all kinds grow with great luxuriance, so long as they contain a goodly portion of the original humus; but, when this has disappeared, the soil becomes very unproductive: it loses its tilth and ability to hold moisture and becomes easily eroded and gullied by rains. This is almost the prevailing condition in all the older fields throughout East Texas, where continuous waste by cropping and washing have gone on for years without thought of remedy. In spite of these facts the soils of East Texas are more easily maintained in good tilth and fertility, and quicker restored after loss of it, than any soil that I know of elsewhere. The application of a thin coating of even badly leached barnyard manure increases the following corn crop far beyond the expectations gotten from experiences with other soils. A good crop of cowpea vines plowed under on such impoverished land restores it at once to much higher fertility and better texture; especially will the drouth-resistance of the land be increased to a marked degree. The beneficent effects on the land of such green manure are also noticeable for several seasons, and not as in the case of our commercial fertilizers that simply stimulate one crop, leaving the land, if any change, somewhat poorer for the next crop.

Since all varieties of cowpeas grow so luxuriantly, even on soil made up of loose wind-drifted sands in East Texas, farming could be readily so carried on as not only to maintain the fertility, but to increase it far beyond the virgin conditions. This can be simply and cheaply done: First, by terracing all cultivated land liable to washing; second, by instituting a system of rotation of crops, in which cowpeas for green manure recurs often enough to steadily increase the humus, and hence the fertility of the soil. On very poor soil such a crop of green manure may at first have to be applied every other year; later, as the fertility increases, less frequently.

There is no equal area in the whole State of Texas adapted to so wide a range of agricultural pursuits, nor so cheaply, as East Texas, provided the farming is carried on within the limits of the moderate sized family farm. Farming on the extensive scale, such as is frequently found in the prairie region of the West, is in East Texas a profitless waste of resources and energy. It is intensive farming to which the country is adapted, and of such a mixture as the staple crops of the region—fruits, vegetables, dairying and hogs. The ample and very regular crops of acorns from the forests furnish efficient and cheap hog feed. The Angora goats thrive well on the underbrush and is the cheapest means of clearing the land for cultivation after the larger timber has been removed. The ease with which cowpeas, peanuts, sweet potatoes and other root crops grow gives abundance of feed for all sorts of domesticated animals. Bermuda grass, carpet grass and Japan clover furnish summer grazing. To these might be added by introducing Bur clover and Rescue grass for winter grazing.

To any one who has observed the various regions of the State is this fact evident, that East Texas is the part of the State in which an in-

telligent and industrious farmer can gain independence with the smallest pecuniary start.

Yours very truly,

H. NESS.

Professor Kyle's letter:

THE IMPORTANCE OF EAST TEXAS AS AN AGRICULTURAL SECTION.

For a number of years I have had great confidence in the ultimate success of East Texas as an agricultural country. As a matter of fact, it has been surprising to me that that country has not been settled faster and has not made more rapid progress and development. It seems to me that the principal reasons why the country has not developed faster have been due, first, to the lack of advertisement and, second, to the fact that most of the country is rather thickly wooded, and most of our homeseekers have come from the prairie States and are naturally prejudiced against a wooded country.

There are many reasons why East Texas should become a thickly settled and prosperous agricultural country.

The annual rainfall of East Texas is sufficient for practically all of the agricultural crops grown in this State. In addition to this, I doubt if there is another section in the United States where there is as much running water coming from springs. In passing over the country, it seems to one that it would be almost impossible to select a block of fifty acres without having running water on some part of it.

The soil in East Texas is a sandy, or sandy loam underlaid with porous clay subsoil. This soil not only retains moisture exceptionally well, but gives up plant food when applied in the form of commercial fertilizer exceptionally well. These qualities make it possible to build up the soil in East Texas to a very high state of fertility.

The rainfall, an abundant water supply, and the ability of the soil to produce crops the year round is destined to make of East Texas one of the leading, if not the foremost, dairy country of the United States. As a successful dairy industry is the best basis of all permanent and prosperous agricultural countries, there should be no question as to the future of East Texas. In a great many parts of the world where the dairy industry has become of immense importance it is necessary on account of the extreme cold to house the dairy cow from three to six months during the year. While being kept under shelter, it is of course necessary to use commercial feedstuffs. In East Texas there is hardly a day in the year but what the dairy cow cannot only run in the open but it can have green pasturage to feed upon.

The success of most countries, agriculturally, is in direct proportion to their ability to diversify in the crops grown. It is doubtful if there is another section of the United States where as many crops can be grown as successfully as in East Texas. Peaches, small fruits, such as strawberries, blackberries and dewberries, can be grown to perfection in East Texas. In fact, these have all become staple crops.

In the line of vegetables, the tomato, the Irish potato, cabbage, etc., have become staple crops, and every year bring in large profits to the careful and intelligent grower.

It seems to me that all that is needed in order to make East Texas one of the greatest and most successful farming sections of the United States is, first, proper advertisement and, second, intelligence and energy of the farming classes.

Very truly yours,

E. J. KYLE.

Professor Burns' letter:

COLLEGE STATION, TEXAS, April 15, 1914.

Col. R. T. Milner, Henderson, Texas.

DEAR COLONEL MILNER: I hope you will pardon the delay in answering your letter of March 17th. I have been absent from the College a great deal of late, which accounts for it.

In my opinion, East Texas offers greater opportunities along agricultural lines to both the capitalist and the man of small means than any other section of this State. Being in its infancy in agricultural development, it is possible to buy land there at remarkably low prices, considering the future of that section in comparison with the future of other sections of the State.

With a soil, though not naturally high in fertility, yet most responsive to good treatment; with an average annual rainfall of 40 to 45 inches, and with a mild climate admirably suited to both plants and animals, I can see no reason why East Texas should not develop into one of the foremost farming and stock raising sections of the State. For a long time it has appealed to me as offering especially good opportunities in stock farming and dairying. It also seems to me that farming along these lines would be more in keeping with the needs of the country in the conservation and improvement of soil fertility. Live stock raising and crop rotation will do more to eliminate the need of commercial fertilizer and to establish a permanent agriculture than will any other factors, and there is no section of the State better adapted to this system of farming than is East Texas.

Conditions there seem most favorable for the production of feed crops without which live stock raising cannot be a success. With a high average rainfall and a mild climate it is possible to have permanent pasture of the best kind and green forage crops practically throughout the year. Furthermore, the numerous springs of fresh water entirely solve the problem of water supply for live stock. The country is highly adapted to Bermuda grass, Rescue grass and Bur clover, and we have no combination of plants in this State better suited to permanent pasture than these. With such pasture in connection with forage crops, so admirably adapted to that section, such as Spanish peanuts, cowpeas, rape, oats, wheat, rye, barley, sorghum and sweet potatoes, there is no reason that the raising of all kinds of live stock cannot be accomplished with a high degree of success. Corn can be grown successfully, both for grain and for silage, though sorghum, on account of its heavy yield of forage, may prove better for the silo. With these feeds supplemented with cotton seed products from the oil mills there is no reason why East Texas should not successfully produce dairy products of the highest quality and raise and finish large numbers of meat animals for the market. Such conditions warrant the use of improved live stock,

and no time should be lost by the people in bringing about such improvement.

I have tried to give you my honest opinion of the country without exaggeration, and hope that I have succeeded in describing conditions along the particular line referred to, as they really are.

Very truly yours,

JNO. C. BURNS.

A Plea for Arbor Day Observance*

More than forty States have designated one day in the year, known as Arbor Day, on which to observe the time-honored custom of planting trees. In Texas Arbor Day comes on Washington's Birthday, February 22. Let us resolve to make the day memorable this year, if never before, by setting out trees where they are most needed.

Examine the community conditions about you and then ask yourselves these questions:

Are the streets of the town suitably planted and are the trees well protected against injury and properly cared for? Is there no chance to improve the country roadsides by planting trees? Does the town support one or more parks with green grass, flowers, shrubbery and trees? Do the school grounds and other public places look bare and neglected or are they well planted? Would not a few trees and some shrubbery improve the appearance of the home grounds? Is it not possible that a few rows of trees to protect orchards, fields and buildings or a grove to later supply the farm with fuel and posts would be desirable?

Most of us can see where additional trees would be a source of pleasure and profit to us individually and as a community. Firmly believing in tree planting, then let us decide this year to accomplish some definite results which we can point to with pride in after years. Let us not plant hurriedly and without plan or reason but after careful consideration of the needs and with well made plans as to how the work should be done and where suitable trees may be secured. It is important to plan ahead and to work together if we are to accomplish effective results and really make Arbor Day a memorable one. What is needed first of all is a leader in each community to carefully work out the details of a plan of operation. Such a leader might well be some local civic organization, the woman's club, the teachers in the local public schools, the demonstration agent or, in fact, any individual or group of individuals willing to render this community service. There is every reason to believe an organized plan for carrying out Arbor Day planting, properly led, would find many followers among the residents and children of each community.

*Supplementary to Bulletin 2, Department of Forestry, entitled "Tree Planting Needed in Texas." For further information write to State Forester, College Station, Texas.

The plan of operation should determine first of all where trees are most needed, how many will be required to complete a definite amount of effective planting, what species are best adapted to specific places, where they may be secured, who will do the planting, and what the expense, if any, will be. Then let the trees, whether wild or nursery grown, be secured by one person in advance, thus saving time, expense and confusion. They can be "heeled in" at convenient places and in perfect safety many days in advance of Arbor Day. The teachers in the schools should be enlisted and each pupil might well be given a certain part in the actual work of planting. Every detail should be worked out in advance so that when Arbor Day comes each person will know what part he has to perform.

There is but one prerequisite to success in such a community observance of Arbor Day—a leader who is willing to make the plans and see that they are carried out. It is a worthy undertaking and need not be done on so large a scale as to make its difficulties seem insurmountable. Leave the greater effort for another year. Arbor Day comes and goes. Some planting is done but much is left undone. If someone will take the lead in each community and a combined effort is made to plant trees on Arbor Day, we will be so pleased with the results that next year there will be no lack of interest in Arbor Day observance.

In conclusion, let us observe the spirit of Arbor Day in its broadest conception, bearing in mind that tree planting is only a factor in making life full and complete. The building up of new resources and the husbanding of those nearing exhaustion, the saving of wild life, the prevention of waste, and the improvement of our living conditions are thoughts which should come to us in connection with Arbor Day.

"Give fools their gold, and
knaves their power;
Let fortune's bubbles rise
and fall;
Who sows a field, or trains
a flower,
Or plants a tree, is more than
all."

—WHITTIER.

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GRASS AND WOODLAND FIRES IN TEXAS

BY

J. H. FOSTER

STATE FORESTER OF TEXAS

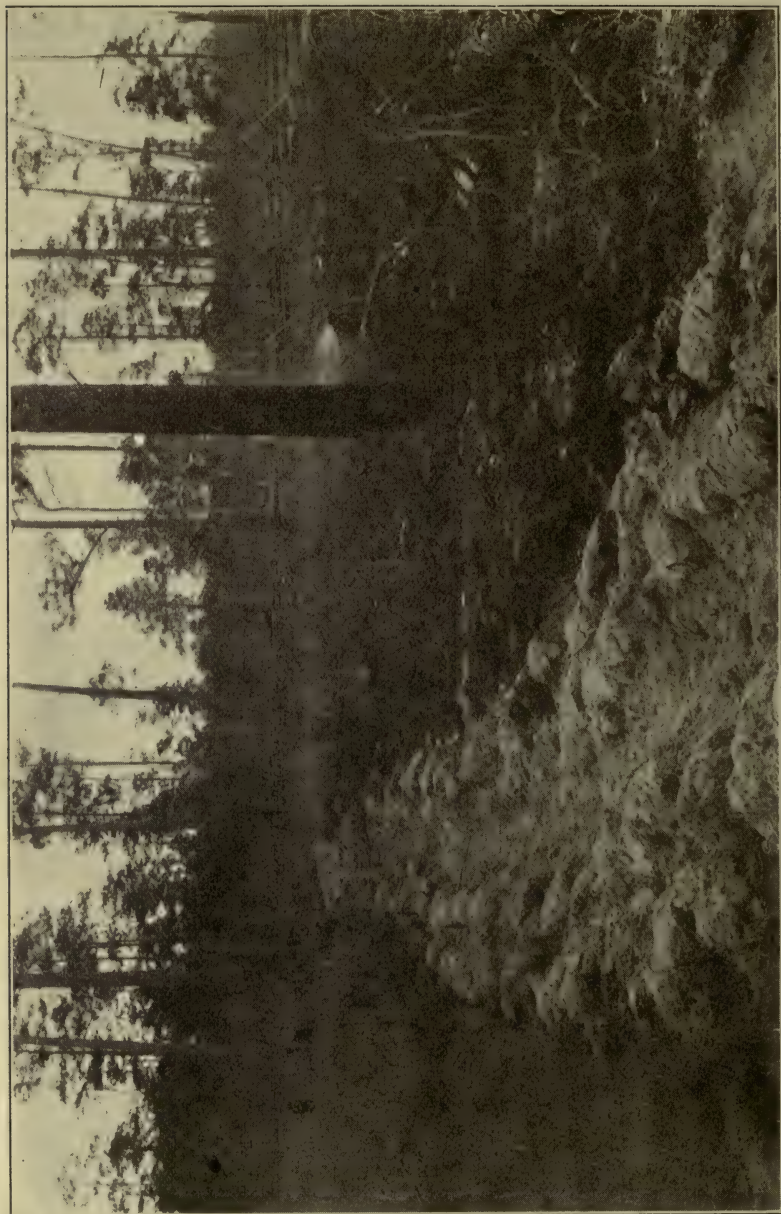


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SURFACE FIRE CHECKED AND BEING EXTINGUISHED BY FURROWS HASTILY PLOWED

GRASS AND WOODLAND FIRES IN TEXAS.

The frequent and repeated burning of woodlands, pastures and cut-over areas is the most serious and deceptive problem which confronts the forest interests of Eastern and Central Texas. Less directly it concerns agriculture in general and the welfare of the entire State. This problem is serious because the injury done is so widespread and far reaching in its effects. It is deceptive because the damage is not generally recognized. There are strong reasons why these fires which burn so stealthily and apparently harmlessly over so wide an area every year are a menace to the public welfare and imperil the prosperity of individual land owners. They destroy countless millions of seedling trees which future generations of people must depend upon for their wood and timber supply. They destroy the humus covering of the soil which absorbs and holds the rainfall, prevents soil washing and the rapid run-off of water into the streams and rivers. By destroying the humus covering of the soil, fires are responsible in a large measure for disastrous floods, drying up of streams, failure of water supplies, silting of river channels and the abandonment of streams for commercial purposes. The burning of the humus destroys the nitrogenous plant food which would otherwise enrich the soil, thus depriving the land owner of fertility which nature has stored for him. Yet there are many people who indicate by their word and by their attitude that they believe there is no damage from grass and woodland fires. They forget or never knew that in the earlier days streams were clear and siltless as compared with those of today; that many rivers now clogged with mud and debris were once avenues of commerce; and that springs and small streams now often shallow or dry three or four months of the year were once deep and everflowing. This is because lands which were heavily forested have now been stripped of their timber and the humus covering of the soil destroyed by repeated fires. Slopes and the sources of streams are all too frequently gullied and washed as a result of forest and humus destruction and failure to use proper methods of cultivation where sloping lands are cleared. This fire problem has a very important bearing on the future welfare of the people of this State. Control of grass and woodland fires and better management of cleared slopes are two agencies which can bring back normal and proper conditions.

NECESSITY OF GROWING TIMBER FOR THE FUTURE.

Man needs wood in a multitude of forms. It is probable that future generations will need it in the same variety of forms and in nearly the same proportionate quantities as now. We should realize that they who come after us have the same right to be provided with timber that we have to the use of timber today. The wood-using industry is directly

productive, not destructive, in the sense of supplying the needs of man. It is one of the three great manufacturing industries of Texas, employing over 25,000 persons and producing a value in manufactured products of \$32,000,000 a year, two-thirds of which goes to wage earners. It consists of 800 separate establishments and each year turns into the channels of commerce two billion feet of lumber, laths and shingles, in addition to millions of railroad ties and cords of wood, enormous quantities of telegraph and telephone poles, fence posts, cooperage stock and a wide variety of other products. It is impossible to measure the extent of these products in terms which one may easily understand. Commercial timber is produced in a large scale in only 12 out of 168 million acres in the State. To meet the demand, conservative estimates by the government* indicate that there is a supply of standing timber within the timber belt of Eastern Texas of about sixty-six billion feet, two-thirds of which is yellow pine. There are some large holdings where lumbering operations have not yet begun and which will require the building of additional large mills, but with a few exceptions the big manufacturing plants in operation today will be abandoned in ten to twenty-five years. There is no storehouse of timber beyond the next few decades at the most. To satisfy the demands of a greatly increasing population in the future the supply of timber must come from new growth within the State or from outside the State, chiefly from the Pacific northwest, which now contains one-half of all the remaining timber of the United States. The consumer in Texas will have to pay a greatly increased price for his lumber with the freight. Even the home-grown timber of the future will have a much higher value than at present.

Let us look ahead to this timber supply question with a view to safeguarding our own local needs and also growing timber to sell outside the State. The passing of the lumber manufacturing business as it is known today in East Texas is inevitable. One would not even wish to continue it on such a gigantic scale. The lumber industry of the future will be carried on by portable and combination mills and small, permanent establishments which will pay good prices for the products of farmers' woodlands, furnish labor to farmers and their teams when not otherwise engaged, and in general promote agricultural prosperity rather than retard it, which is now frequently the case. Texas can produce all the timber it will require for all time within its present forest regions by growing new forests on the lands which are likely to remain unimproved. The fear is that these new forests will not be started soon enough.

Safeguarding the future timber supply of our State is not only a problem of wide significance but the growing of young timber is a matter of good business sense and judgment. Owners should encourage young forests on their cut-over, waste and idle lands. In 1899 the value of forest products from the farms of Texas amounted to three

*The Lumber Industry, Part I. Standing Timber, U. S. Dept. of Commerce and Labor, Washington, D. C. 1913.

and a half million dollars; in 1909 it had increased to almost nine million dollars. Twenty-five years ago timber upon Texas lands was looked upon everywhere as an encumbrance. In 1900 a stumpage value of forty cents per thousand feet for shortleaf pine and one dollar for longleaf was a fair value. Today they are selling for as high as \$4 to \$5 on the stump. During the decade of 1898 to 1908 standing yellow pine increased threefold to tenfold in value. The timber of the highest value today is poorer in quality than the timber which formerly sold for little or nothing and was an encumbrance to the land. This increase in value is likely to continue at a uniform rate. As larger areas in each county are turned into productive farms the need of timber for local use will increase. The treeless counties of Texas and the Southwest in general will call upon woodland counties for the products of their forests. A rapid increase in population is taking place. The young timber of today must furnish the forest products of the future. Those farmers and land owners who now protect and encourage the growth of young timber will be well rewarded. Forest fires are the chief obstacle to the development of commercial stands of second growth timber without effort or expense to the owners.

It is true that merchantable trees are seldom killed by fires, except pines which have been boxed for turpentine or which are defective or have been injured. It is not true that they escape injury. This occurs through loss of vitality due to excessive heat of fires and destruction of soil enriching humus. Burning opens up cracks and exposes the wood beneath the bark, thus offering avenues of attack for insects, disease and fires which come later. The rate of growth of individual trees and the yield of timber per acre are far below the possibilities when the forests are repeatedly burned over.

The destruction of young growth, however, is infinitely more serious. Almost every acre of cut-over timber land even under present modern methods of logging, contains a sufficient number of seed bearing trees to plentifully restock the land with new growth if grass fires can only be controlled. On such cut-over areas actual counts of 12,000 to 15,000 seedlings per acre have been made in years following a heavy fall of seed. But no trees have an opportunity to reproduce from seed where fires occur every year, or every few years. When four or five years of age longleaf pines become partially immune if protected up to that time. They must be at least eight to ten years old in order to resist grass fires with reasonable certainty.

There is no other serious obstacle to seedling development, except free-ranging hogs, which do eat quantities of seed and succulent roots of young pines. The increasing tendency to keep hogs within enclosures in order to control cholera is eliminating them as a serious menace to forest reproduction. Goats will, of course, destroy forest reproduction but they are not extensively grazed at present.

Shortleaf pine, unlike longleaf, will sprout from the root when the tree is killed up to the age of eight or ten years, after which time the tree fails to sprout and burning will cause greater injury than to longleaf of the same age. Trees from eight to twelve years of age are most

susceptible to serious and permanent injury. The effect of fires in somewhat older stands is to kill many but not all of the trees, causing the stand to be open and liable to attack by borers and disease. Dense, well stocked stands twenty years of age and over are not usually found, except in old fields or on scattered areas where fires have been excluded. The rate of growth of second growth pines is remarkably high when protected from fire.

Thin barked hardwoods like ash and hickory and those which do not sprout easily are destroyed during the seedling stage. Scrubby, upland oaks, sweet gum and many inferior hardwoods, however, develop from sprouts with unusual ease and at almost any age, and as a result of successive fires will often fill the woodlands with useless scrubby growth to the exclusion of better timber.

RESULTS OF HUMUS DESTRUCTION.

The most notable characteristics of our woodland soils today is the absence of humus and decaying vegetation, which should, under normal conditions, cover the surface. Repeated fires are almost entirely responsible for this absence of humus, and as a further effect of them, the exposed surface soil is baked and hardened and becomes impervious to water. Without a humus covering and in this compact condition the rainfall is not absorbed by the soil but passes rapidly down the slopes, gulying and washing them and carrying the surface soil into the rivers and streams. This rapid increase in the volume of the streams causes overflow and injury to farm property. The washing of the soils fills the streams with sand and mud, making them shallow and impeding navigation. During periods of little rainfall springs and small streams become dry, larger rivers are low and water supplies fail, because over the vast areas of forest, cut-over and waste land, devoid of humus because of fires, there is no means of absorbing and holding the rain which has previously fallen. Extremes of high and low water are guarded against through this water absorbing property which humus has. The land surface without humus may be likened to the roof of a house which quickly sheds the rain and as quickly becomes dry when the rain is over. But cover the roof with a mat of decaying vegetable matter and the water cannot pass off until the spongy mat is thoroughly saturated and only then in the form of slow seepage from beneath the mat. It is not a matter of wonder that the springs dry up on the farms; the soils wash into streams and clog them, and the streams overflow their banks after heavy rainfall and are dry at other times. The damage from floods in the Trinity, Brazos, Colorado and other rivers is too well known to require comment. The government has spent nearly four millions of dollars to improve the rivers and harbors of Texas. The damage has been due in large measure to forest and humus destruction. Next to a humus covered forest soil, farm lands in a good state of cultivation and managed so as to prevent soil erosion are the best conservers of moisture. Today, however, the well tilled and managed areas are separated often by wide stretches



FOREST LAND REPEATEDLY BURNED OVER

Absence of reproduction and the bare exposed soil on slopes cause rapid run-off of water



TYPICAL FIRE BURNING IN TEXAS WOODLANDS

Seedling trees and humus covering of soil are being destroyed

of cut-over and burned forest or waste lands capable of being nature's best means of water conservation, but in their present condition offering little assistance in this important function.

By means of leguminous crops, rotation, soil building, terracing, fruit and truck farming areas formerly occupied by forests are being used profitably and prosperous communities are springing up on lands not long ago in timber. It is probably safe to state that agriculture will ultimately demand the use of the larger proportion of our present soils. In spite of this fact hundreds of thousands of acres will remain unimproved for a great many years, perhaps for all time. Further, every community is better for a certain per cent. of its land area in productive forests; every farm should have its wood lot, whether it be only five or as much as fifty per cent. of the farm area. It is impossible to foretell which lands will be cleared and which will not. In this connection humus in the soil plays another important rôle aside from moisture conservation, that of a natural fertilizer. This vegetable soil covering so easily destroyed by grass and surface fires, contains the nitrogenous food materials so necessary to maintain plant life and the fertility of a soil. When humus is burned the nitrogen passes into the air as a gas and is entirely lost to the soil. Nature furnishes this fertilizer free and asks only fire prevention in order to preserve it for future use. Observations show that in the space of two or three years where no fires have burned, an average woodland soil will accumulate nearly an inch of good humus cover. Annual burning, however, has robbed and is continually robbing, these lands of the humus which will be needed when the land is cleared for farms, and of the humus and young growth which are needed if the land remains in forest. There is no argument against fire prevention because of the fact that large forest areas will eventually be cleared for farms. Normal conditions for the future can be brought about only by building up a new soil humus by means of fire prevention and by the extension of proper systems of cultivation. Forestry and general agricultural development must work together toward this end. The preservation of a future timber supply and the building up of humus in the soils are important economic questions of this generation.

OTHER INJURY BY FIRES.

Annual burning is responsible for other damages perhaps more immediate and more closely concerning the individual farmer, stock raiser, and land owner, who look upon fires as unimportant and inevitable. The damage done to fences, buildings and other improvements seldom reaches the attention of the general public, although in the course of a single year amounts to a tremendous sum in money and labor. Live stock is frequently endangered by fires. Farmers and stock raisers as a whole are coming to realize that fires do not improve the pasturage. Authorities on the subject have always agreed that burning decreases the quality and abundance of forage grasses and tends through soil impoverishment to aid in the survival and ultimate domination of weeds

and scrubby growth because they can recover from repeated fires. There is undoubtedly a temporary advantage to grazing in the removal of dry grass during the early spring before the new grass is well started, but the writer knows of localities where the only areas in good grass throughout the season are those which have not been burned over. Fall fires destroy grass which otherwise could be grazed well into the winter. Any beneficial result of burning is a hundredfold offset by the variety and magnitude of the injuries which follow.

THE COST OF DAMAGES BY FIRES.

Systematic efforts have never been made to estimate the damages caused by fires in Texas. The census of 1880 placed the damage in salable products and improvements on 600,000 acres burned over annually at \$274,000. In North Carolina a record of forest fires has been kept each year since 1909, where the average area burned annually is 415,000 acres and the average annual damage to timber, young growth and improvements is \$648,000. This loss is equivalent to a tax levy of 36 cents on \$100 on all the land in North Carolina, or 13 cents on \$100 on all property, real and personal, now listed for taxation. This is paid year after year by the people of that State without a murmur. The loss in Texas is scarcely less than in North Carolina and would amount to millions of dollars if the cost of humus destruction, soil deterioration and damage to the streams and overflowed areas were added. During the recent drouth of February and March not less than 50 per cent. of the woodland area of Eastern Texas has burned over. Several lumbermen have stated that they believe the area burned over to be nearer 90 per cent. This is a question of vital importance and concerns the future welfare of every man, woman and child in Texas.

CAUSES OF FIRES.

The immediate causes of forest fires are many. The responsibility for the tremendous areas of land burned over annually, however, is due to carelessness, general indifference and the lack of information as to the damage done. In North Carolina 50 per cent. of all forest fires are caused directly by carelessness and indifference; 25 per cent. are caused by railroads and logging engines; 15 per cent. are started intentionally to improve the range or to see the fire burn; and the balance are due to numerous known and unknown reasons. The causes of fires in Texas are probably not far different than in North Carolina, where similar conditions prevail. Railroad section foremen frequently leave piles of ties burning along the rights of way when the wind may carry the fire to adjoining property. Boys and men often touch a match to a dripping turpentine tree or start a fire in the grass "just to see it burn." Hunters and others carelessly throw down burning tobacco or matches with never a thought of first extinguishing them. People all too often start fires to clear land or protect their fences and buildings and let the fire run as far as it will in a direction which does not endanger their property. Many fires are started because of the erroneous

belief that they improve the range. There are still a few people who believe that burning is necessary in order to check the ravages of the cattle tick. The tick will never be eradicated or the quarantine removed by burning over the land, but may be controlled by rotating the stock within fenced pastures or dipping the stock. There is an unfortunate opinion expressed now and then that burning is necessary in order to facilitate travel in the woods, to get rid of insects and snakes and to improve the general healthfulness of the community. Only rarely are fires started with malicious intent to injure property. Most fires are entirely unnecessary and avoidable.

CONTROL OF FIRES.

Fire is an indispensable agent when rightly controlled. It is a vicious and ruthless destroyer when uncontrolled. No one who has carefully studied the woodland fire problem in Texas can believe that fires should be entirely prevented. There are conditions of extreme hazard which may and should be removed by burning, but all such burning should be restricted to certain areas and never be permitted to run over adjacent property. While burning under certain conditions is highly essential, yet between a proper use of fire and promiscuous, unrestrained burning there is a wide difference. Owners of land who desire to keep their lands fire free should be allowed to do so without question and with only reasonable concern for the safety of their property, or else be fully repaid for all damages incurred. Today an owner has no assurance that his land will not burn over at any time, and he has little recourse when the damage has been done, unless the blame can be charged to a railroad or some other corporation. There are instances at hand where farm wood lots in agricultural communities, apparently safe because of their isolation from other woodlands, burn over year after year in spite of precautions which the owners take themselves. Very little chance has the owner surrounded by uncultivated areas or crossed by railroads to keep his land free from fire. Every owner has a right, of course, to burn over his own land if neighboring property is not injured or endangered as a result. It is equally the right of every owner to be protected in his property. The forest fire laws of Texas recognize these rights, but in order that the laws may fully accomplish their purpose, a strong public sentiment against fires is necessary.

The most serious hazard which should be removed by burning is the accumulation of large quantities of slash from logging operations. It would be desirable if such slash could be thrown away from sapling and pole trees during logging and burned when the slash itself is dry but when the ground and humus are wet enough to prevent the destruction of the humus and the spreading of fire to other property. Such burning of cut-over land is generally recognized as essential to securing the best reproduction from seed, in the case of longleaf pine. Following lumbering and the burning of the slash, fires should be absolutely excluded for a period of years. With longleaf pine this period may be



GENERAL APPEARANCE OF CUTOVER AND BURNED PINE AREA
Note how a recent fire was stopped by the road



DENSE SAPLING PINE IN REAR OF FENCE IS RESULT OF PROTECTING THIS
AREA FROM FIRE; FOREGROUND IS BURNED CLEAN

considered to be from eight to ten years, but with shortleaf it should be much longer.

Grass fires under stands of mature or well developed timber, especially on level land, do less harm than in most other places and may be tolerated until the time comes after logging when reproduction should be provided for.

In the protection of buildings and fences, and in confining fires to restricted areas, fire lines are helpful. A double plowed furrow stops slowly burning surface fires and is a good base from which to stop others. It is better to plow one or more furrows on each side of a strip four to eight yards wide and burn the intervening ground. Fire lines around areas of thrifty seedling or sapling growth are desirable, as well as about logged off land which the owner desires to burn. The burning the litter and debris about farms, along public roads and railroads, and wherever else burning is desirable, should be done in such manner and at such times that the fire cannot spread and when there will be the least possible damage to humus and soil. The time of year, weather conditions and direction of wind during the time of burning are most important. A few days after a heavy fall of rain when the humus is moist and only the debris and litter are dry enough to burn is the best time. Fires should be scrupulously guarded against during windy weather and hot dry periods when the humus as well as the surface litter and grass are excessively dry. Generally the most suitable conditions for burning are found during the winter months.

Many States have fixed policies for controlling the use of fire. In most Northern and Western States written permits to burn during dry months of the year must be secured from a county or township fire warden. This applies equally to railroad section foremen in burning ties or strips along the rights of way, and to public road officials, farmers and all land owners and persons who are clearing land or disposing of debris. By this means many fires are prevented and the responsibility for the escape of others is more easily fixed. In some States the disposal of slash after all cutting of wood and timber is required by law and under proper supervision to prevent the escape of fire. Fire lines are often required after logging on private lands bordering public highways and railways. This is what is meant by control of fire. Promiscuous burning, not controlled burning, should be prevented.

The posting of fire notices is a distinct aid in controlling fires. The Forestry Department is already gaining the attention of the general public in this way. Private owners should post their lands with notices urging all persons to be careful not to start fires. When posting lands against hunting, fishing or general trespass, a clause against fires should be included. The State Forester will furnish general fire notices free upon request and advice as to how specific notices may be worded.

The Texas Legislature recognized the importance of fire prevention as far back as April 14, 1883, when the following law was enacted to prevent the burning of woodland and prairies:

Burning Woodland or Prairie—Penalty. If any person shall wilfully or negligently set fire to, or burn, or cause to be burned, any woodland

or prairie not his own, he shall be punished by fine not less than fifty nor more than three hundred dollars.

Offense Complete, When. The offense named in the foregoing article is complete when the person offending sets fire to his own woodland or prairie and the fire communicates to the woodland or prairie of another. (Acts of 1883.)

The following clauses have been enacted in the years following:

Firing Grass in Enclosure of Another—Penalty. Any person who shall wilfully fire any grass within any enclosure not his own, in this State, with intent to destroy the grass in such pasture, or any part thereof, or any person who shall fire the grass on the outside of any enclosure with intent to destroy the grass in such enclosure, by the communication of said fire to the grass within, shall be deemed guilty of a felony, and upon conviction, punished by confinement in the State penitentiary for a term of not less than two nor more than five years. (Acts of 1884.)

Game, Fish and Oyster Commissioner and Deputies Made Fire Commissioners; Duties of. The Game, Fish and Oyster Commissioner and his deputies appointed under the provisions of this chapter are hereby made fire commissioners, and it shall be their duty, in addition to their duties provided for in this chapter, to caution sportsmen or other persons, while in the woods or marshes or prairies, of the danger from fire, and to extinguish all fires left burning by anyone, to the extent of their power, and to give notice to any and all parties interested, when possible, of fires raging and beyond their control, to the end that same may be controlled and extinguished. (Acts of 1907.)

State Forester—Action Regarding Fires. * * * He shall take such action as may be deemed necessary by said board to prevent and extinguish forest fires, shall enforce all laws pertaining to the protection of forest and woodlands, and prosecute for any violation of such laws. (Acts of 1915.)

When public sentiment is thoroughly aroused to the real damages resulting from the widespread and unrestricted use of fire carelessness will cease, indifference on the part of individuals will change to active support, and irresponsible persons will be controlled. The ease or difficulty with which fires may be controlled in a given section will depend to a considerable degree upon the attitude of individual land owners. It is absurd to expect fire protection where all or most of the owners do not care whether fires burn over their lands or not and are unwilling to take any initiative themselves toward securing protection. Every farmer and other owner of property in rural sections and every thinking, intelligent citizen in the towns should rally in support of fire control measures. Every newspaper should lend its influence. Teachers in the rural schools should point out to their boys and girls the damages caused by fires and help to bring about the far-reaching influence for good which lies in their power. Public sentiment freely expressed is necessary in order to bring results. Systematic means of handling the fire problem can be brought into action as soon as the general public

determines that promiscuous fires are an unnecessary and avoidable evil. Until that time it is useless to formulate detailed, protective measures.

Each county where the fire problem exists should ultimately have a fire warden and enough deputies to control fires started by irresponsible persons and see that legitimate fires are kept within proper limits. Such a county fire warden system should be under State supervision, and the expenses of its maintenance should be paid by the State or the counties, or shared by both. The majority of States now handle the fire problem in this way.

The Federal government recognizes the importance of fire protection as an indispensable aid in controlling the flow of streams. In 1911 Congress passed a law which authorizes the Forest Service of the Department of Agriculture to co-operate with and aid those States which appropriate money for fire prevention purposes on the watersheds of navigable streams. Since the greater part of Texas contains streams recognized as navigable, it is possible to secure the benefit of Federal aid to the extent of \$10,000 a year when State appropriations for the same purpose and on the same areas amount to at least this sum. At the present time Texas is co-operating with the government to the extent of \$2500. The government aids in this work by paying for the employment of patrolmen during the hazardous months of the year. An agent of the State Forester is now devoting his entire time to fire protection, chiefly along educational lines and in distributing fire notices. He will also supervise the Federal patrolmen to be employed. As the people become acquainted with the nature of this work and approve of it, both State and Federal efforts will unquestionably be extended.

As already stated, however, the damages from grass and woodland fires must be recognized and a sentiment aroused against burning before any degree of success can be assured. Once the general public uses its influence to prevent fires, control by means of an organized system will be comparatively easy.

APPENDIX.

TEXAS FORESTRY LAW.

(Act of 1915.)

SECTION 1. *State Forester—Appointment—Qualifications—Compensation and Expenses—Assistants and Employes—Action re Fires—Prosecution by—Forest Data—Co-operation—Reports by.* There shall be appointed by the Board of Directors of the Agricultural and Mechanical College of Texas a State Forester, who shall be a technically trained forester of not less than two years experience in professional forestry work; his compensation shall be fixed by said board at not to exceed three thousand (\$3000) dollars per annum, and he shall be allowed reasonable traveling and field expenses incurred in the performance of his official duties. He shall, under the general supervision of said board, have direction of all forest interests and all matters pertaining to forestry within the jurisdiction of the State. He shall appoint, subject to the approval and confirmation of said board, such assistants and employes as may be necessary in executing the duties of his office and the purposes of said board, the compensation of such assistants and employes to be fixed by the said board. He shall take such action as may be deemed necessary by said board to prevent and extinguish forest fires, shall enforce all laws pertaining to the protection of forest and woodlands, and prosecute for any violation of such laws; collect data relative to forest conditions, and to co-operate with land owners as described in Section 2 of this act. He shall prepare for said board annually a report on the progress and condition of State forestry work, and recommend therein plans for improving the State system of forest protection, management and replacement.

SEC. 2. *Co-operation in Preparing Forest Working Plans—Expense.* The State Forester shall, upon request, under the sanction of the Board of Directors, and whenever he deems it essential to the best interests of the people of the State, co-operate with counties, towns, corporations or individuals in preparing plans for the protection, management and replacement of trees, wood lots, and timber tracts, under an agreement that the parties obtaining such assistance pay at least the field expenses of the men employed in preparing said plans.

SEC. 3. *State Forests—Acquirement of Lands—Use of—Funds Available for—Title Deeds.* The Governor of the State is authorized upon the recommendation of the Board of Directors to accept gifts of land to the State, same to be held, protected and administered by said board as State forests and to be used so as to demonstrate the practical utility of timber culture and water conservation, and as refuges for game. Such gifts must be absolute, except for the reservation of all mineral and mining rights over and under said lands, and a stipulation that they shall be administered as State forests.

The Board of Directors shall have the power to purchase lands in

the name of the State, suitable chiefly for the production of timber, as State forests, using for such purposes any special appropriation or any surplus money not otherwise appropriated, which may be standing to the credit of the State forestry fund.

The Attorney General of the State is directed to see that all deeds to the State of land mentioned in this section are properly executed before the gift is accepted or payment of the purchase money is made.

SEC. 4. *State Forestry Fund Created.* All moneys received from the sale of wood, timber, minerals or other products from the State forests, and penalties for trespassing thereon, shall be paid into the State Treasury and shall constitute a State forestry fund, and the moneys in said fund are hereby appropriated for purposes of forestry in general, under the direction of the Board of Directors.

SEC. 5. *Annual Appropriation for State Forestry Fund.* For the maintenance, use and extension of the work under the Board of Directors, and for forest fire protection, there is hereby appropriated the sum of ten thousand (\$10,000) dollars annually out of any moneys in the State Treasury not otherwise appropriated, to be placed to the credit of the State forestry fund.

SEC. 6. *Co-operation with Federal Forest Service.* The Board of Directors may co-operate with the Federal Forest Service under such terms as may seem desirable.

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TREE PLANTING NEEDED IN TEXAS

BY

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BULLETIN 2

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PALMS_FLOURISH IN THE PARKS AND GROUNDS ALONG THE GULF COAST.



BEAUTIFULLY PLANTED AVENUE IN A NEW RESIDENCE SECTION OF DALLAS

PREFACE

TREES.

Trees are the arms of Mother Earth lifted up in worship of her Maker. Where they are, beauty dwells; where they are not, the land is ugly, though it be rich, for its richness is but greasy fatness and its gaudy raiment is but cheap imitation of forest finery.

Trees are the shelter of man, beast and bird; they furnish the roof above us, the shade about us and the nesting places of love and song. They call children out to play; they entice sweethearts into leafy coverts to seal their vows with fond caresses; they console and gratefully reward old age. They are the fittest ornaments of wealth and the inalienable possessions of the poor who can enjoy them without having title to them. They are the masts that fly the flags of all nations and the sails of all seas; they are the timbers that bridge forbidding streams; they bear the wires of the world's intelligence; they hold the rails that carry the traffic of the continents; they are the carved and polished furnishings of the home; they cradle the young and coffin the dead.

Trees are nature's prime sources of food; their fruits and nuts gave sustenance to the first tribes of men and are the sweetest and most nourishing of the earth's products.

Trees herald the spring with glorious banners of leaf and bloom; they clothe the autumn in garments of gold and royal purple; bared to the winter's cold, they are the harp of the winds and they whisper the music of the infinite spaces.

Before the earth could be peopled, it was set thick with trees; and when man has run his course and the race we know has disappeared in the completeness of its mission or perishes in the destruction of its trees, the earth will spring up again with new forests to shelter and sustain a new race of men and beasts and birds to work out a greater destiny. Perhaps if we are wise enough to replenish our wasting forests and to make ourselves worthy of the gift of trees we may be permitted to accomplish that greater destiny which the Mighty Forester, the Perfect Orchardist, the Loving Father, requires in the fulfillment of His sublime purpose.

CLARENCE OUSLEY.



EFFECTIVE STREET PLANTING IN DALHART, IN THE EXTREME NORTH-
WESTERN COUNTY OF TEXAS.



A PLAINS HOME MADE ATTRACTIVE BY WELL ARRANGED TREES.

TREE PLANTING NEEDED IN TEXAS

The planting of trees along streets and about homes has been going on since Texas was first settled. Countless millions of young trees have been dug from the woods and bottoms and transplanted in order to improve and beautify communities and homes throughout the State. It would be difficult to find a town or rural homestead where such planting has not been done to some extent. Yet tree planting in this State has barely commenced. There is an unlimited opportunity to grow trees for a wide variety of purposes. We have not yet begun to plan for the future in our tree planting. There is a lack of system and foresight in much of the planting done in the past. We do not appreciate the satisfaction which would be felt in later years for trees wisely selected and properly planted today.

Town and city streets should be planted, not as a result of scattered individual efforts, but according to definite plans for the selection of species, regularity in planting, and proper care of the trees afterward. Shade trees are important in front of vacant lots as well as in front of residences. Every city should have its parks, the smaller ones near business centers, to serve as beauty spots and rest places and to vary the monotony of pavements and buildings. Green grass, cool shade of trees and scattered seats attract the visitor and soothe the mind and body of citizens. Larger parks and playgrounds have their place in the outskirts of every city. Ordinances should be passed in order to protect trees on streets and in parks. No city is too small to make these provisions.

School grounds are often destitute of shade trees and almost invariably are less attractive in appearance than other grounds in the community. Country roadsides are not only unplanted and neglected so far as efforts at beautification are concerned, but in some instances they are despoiled of the trees nature has grown there through needless and almost wanton cutting by county road officials. There are many other places and conditions where planting is not as yet considered but where there is a distinct and increasing need for trees. Fence posts and fuel for farms and ranches in many treeless counties can be grown at home. Most farms in Texas need windbreaks and shelter belts to protect crops and buildings from hot, drying winds in summer and cold blasts in winter. Trees as shade for stock and to benefit crops, groves to furnish home supplies of fuel and posts and other forms of planting for profit in fruit and nuts, as well as to make treeless farms and homes more attractive, call for new thoughts and demand our present consideration.

The difficulties in growing trees where rainfall is inadequate and conditions are not the most favorable for tree growth should only stimulate a desire to succeed in planting. There are unquestionably many

species of trees as yet untried which are adaptable to the western portion of Texas. It is the desire of this department to encourage an interest in tree planting of all kinds and to aid with advice, experiments and demonstrations in this laudable work.

STREET TREES.

Every street, unless it be the business street, should be evenly and uniformly planted. Single species are preferable to a number of different species for a given street since greater regularity can thus be secured. It is unfortunate that town lots are allowed to remain without trees until the houses one by one are erected. The average city street today has some lots well planted, others poorly planted and still others, generally where there are no buildings, without trees entirely. Uniformity in a street cannot be obtained so long as this practice is continued. Owners should act together in selecting trees and having them planted by competent persons, or else, as is customary in States where trees are given the best attention, the entire work should be done by the town or city and assessed to all property owners. It is impracticable to correct mistakes in past planting but it is easy to secure uniformity when new streets are being laid out. Some of the best city planting in Texas today is done by real estate concerns which are opening new subdivisions.

It is the duty of the city as a whole to see that property owners conform to well established rules covering the planting, spacing and species to be used and to protect the trees from injury by horses, careless contractors, who may fasten guy wires to them or dump building material against them, mutilation by careless linemen and the numerous other sources of injury to which trees are exposed. Building regulations are accepted as the only means of securing safety and uniformity in construction. Why should not similar regulations be enforced to secure the right kind of street planting, care and protection? A small city can as well safeguard the welfare of its street trees as a large city. Many years are required to develop good trees and their value is too priceless to permit them to be butchered by linemen, teamsters and workmen and injured through the neglect or at the whim of property owners. Most people by nature love the trees and desire to see their welfare secured. This can best be done by placing the entire care of the street trees in the hands of a competent person or commission of the city and enacting suitable ordinances with penalties for their violation.

It is common practice in this State to dig wild trees in the woods and bottoms and plant them out. Most of the fine old trees in towns and cities were secured in this way. Wild trees are not so good as trees grown in nurseries under cultivation, but, nevertheless, this has been our source of trees in the past and will continue to be for many years to come. A little care in selecting and planting such trees will be repaid by far better results. Many species have been planted which have not proven to be best in the long run. While hackberry is the commonest planted tree in the State, there are many sections where

other species would be preferable. One should determine which species seems to be the best available for planting and then give the utmost care to digging, planting and later care of them.

CITY PARKS.

The time to establish city parks is when towns are small and land is cheap. There are notable examples among the newer towns of western Texas where areas have been donated, or purchased, and set aside for future parks and playgrounds. In many towns areas unsuitable for building purposes, such as stream banks and uneven land, may be cheaply and wisely selected for park purposes. Suitable parks are rare in towns or cities with populations of less than 8,000 to 10,000 persons. The future importance of parks is little considered by the people of smaller communities. Public spirited persons owning real estate in small places could leave no better monument than the gift of a park site to their towns. Boards of trade, women's clubs and other organizations can render a real service to their fellow citizens by working for their establishment. The time must inevitably come when a city without parks must spend large sums of money in order to obtain them. This is true of park development in many of the large cities today.

The stranger is greatly impressed by the appearance of a city which has parks and rest places scattered conveniently about the business as well as the residence sections. He goes away feeling he has visited a place which he would be glad to make his home. Such a city is benefited in a business way, grows in population, improves in the health of its citizens and increases in the esteem of every visitor. There are many types of parks which add beauty to a city. Among these are small triangular plots at intersections of avenues, narrow strips of green here and there, open land about public buildings and rest places near busy streets, with convenient benches, plenty of trees for shade, green grass, flowers, shrubbery and drinking fountains, where people may stop for a moment and children may play. A little care and watering will keep most park lawns in fine condition without the necessity of annoying "keep off the grass" signs.

Trees should be planted in parks as soon as they are established, even if other improvements are not made at once. In the larger parks as many different species as possible should be selected and the trees labeled so that people may learn to distinguish them by name and increase their interest in trees. If the soil about the trunks is loose, free from grass and well watered there are kinds of trees without number which can be grown in every section of Texas. In many of the new cities of the Panhandle there are parks in process of development which will be a lasting tribute to the foresight and progress of their citizens. The fine old cities of the United States which appeal to the resident and visitor owe much of their attractiveness to the parks and trees. Let us plan ahead so that our towns, rapidly increasing in size and importance and destined to become prominent cities of the future, may have the benefit of well arranged parks and beautiful shade trees.

IMPROVING THE HOME GROUNDS.

It is a credit to the home loving and home making instincts of our people that tree planting and the preservation of native trees about the home grounds is general throughout Texas. On the farms and ranches as well as in the cities and towns of the plains section it is gratifying to see the painstaking efforts to grow trees, even under conditions extremely unfavorable to tree growth, and the success which attends such efforts. Farther east, where trees grow naturally and thrive with little attention, the home grounds become bowers of verdure and furnish the most comforting and restful shade. Under these favorable conditions a large variety of species is possible and planting is extensive. Neglect in pruning and in the general care of trees, however, is far more noticeable than in western sections. The grounds about the average home in Texas, whether allowed to become a tangle of trees and shrubbery or arranged formally and given the greatest care, indicate a love of trees and a desire to make the home attractive even where street and roadside trees may be neglected.

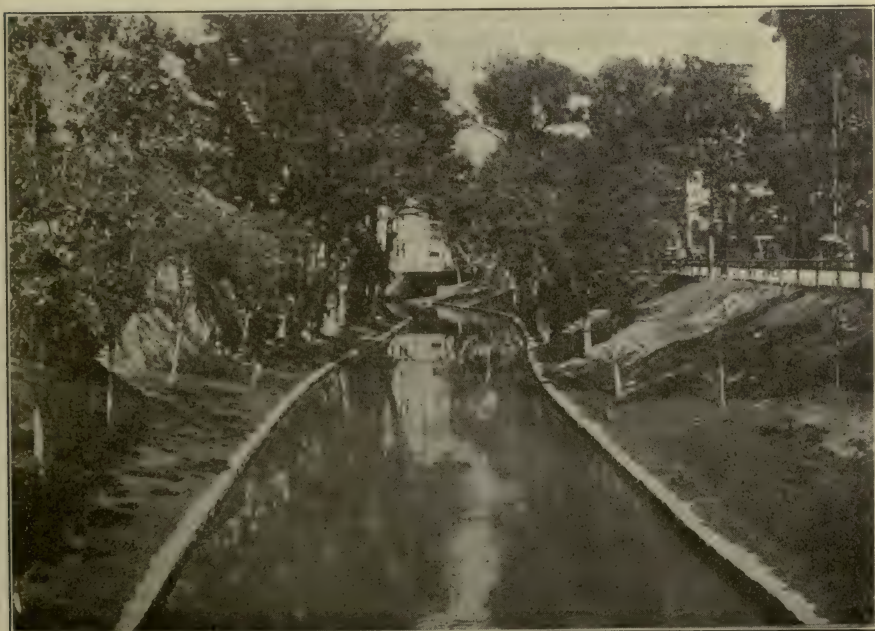
Success in the planting of home grounds is much more easily attained than along streets and roadsides. There is less danger of injury by man and beast and the trees benefit from the superior soil conditions, watering and mulching, which too often are not supplied to the trees outside the grounds, but which the owner is painstaking to give the trees about his house. Our grounds may be made more beautiful, however, by selecting species for planting which are known to be long lived and free from undesirable habits and by giving the trees more attention when young as well as when old. A much wider range of species may be planted than is practiced at present, and it is often of interest to use as many different kinds as possible. Fruit and nut trees have their place in the home grounds and may there be made to furnish shade and the best of fruit and nuts at the same time. Coniferous evergreen trees are particularly desirable for home grounds, but should not be planted close to buildings. Banks of shrubbery are most desirable near the house, while trees should be placed some distance away to allow for better circulation of air in summer and prevent injury to buildings from dampness. Thin foliaged trees, however, may be placed closer than other trees if partial shade to windows and porches is needed. Individual opinion should govern the arrangement of the planting, but in general it is better to avoid a stiff, formal appearance. For this reason groups of trees should supplement or take the place of rows, except along drives or for background effects. Evergreens should preferably be arranged in groups unless they are planted for a hedge.

SCHOOL GROUNDS.

In many cities and most country districts the school grounds are unattractive through lack of trees. There may be a few poorly placed trees, but in too many cases there are no trees at all and the appearance is positively ugly. It is the exception rather than the rule when one



PARK SCENE IN SAN ANTONIO.



BEAUTIFICATION OF A WATERWAY THROUGH THE CITY OF SAN ANTONIO.

finds school grounds well planted and attractive. Flower beds and green lawns are often not compatible with the trampling feet of hundreds of children, but there is no excuse for the absence of shade trees. Fruit and nut trees, of course, are not recommended for school grounds. Trees without edible fruits and with strong branches are preferable for this kind of planting. The boys and girls themselves furnish the motive power and machinery for getting the work done. They would enter with enthusiasm into the project of planting and caring for the trees. The children may even have a nursery for growing the trees from seed. Many schools are already doing this in connection with their class work. What has been said about city parks with reference to labeling the trees applies to school grounds. The children should become acquainted with trees and their habits perhaps first of all from the trees on the school grounds.

COUNTRY ROADSIDES.

Who would underestimate the value of trees lining the hot, dusty highways of the plains, and along the roadsides throughout our rural communities, where trees are not growing naturally? Yet there is a distinct and noticeable lack of such trees along the public highways of Texas. They are needed to help break the force of the wind at all seasons, to furnish welcome, shady spots, which lessen the glare of the sunlight and to make resting places for highway travelers. Tree planting and road improvement should go hand in hand. In many States this is done, and where the State supervises or aids in road construction it is usually the practice to set out trees or to furnish them to the counties or towns. Some state forestry departments are supplying stock at cost for such planting. In Massachusetts an organized forestry association is using its efforts to secure rural roadside planting by offering prizes each year to the towns which plant the greatest number of trees along the country roads. Many States have roadside tree laws and provide for the appointment or election of county tree wardens to supervise roadside planting and prevent needless injury to existing trees. There is an increasing interest in roadside planting in Texas as shown by the efforts of women's clubs and other associations.

Trees should not be so close together or so near the roadway itself as to prevent drying after rains or to interfere with roadway improvement. Especially is the latter to be considered in view of the grading and improvements now being made in almost every county. There is a tendency to remove existing trees where they are growing along narrow roads or too near the roads. Many fine trees are necessarily sacrificed, but many others are needlessly and almost wantonly destroyed. There should be a law to prevent unnecessary cutting of roadside trees.

The time will come, and it is near, when all the principal highways will be avenues of travel for thousands of people from all sections of the State and outside the State. Well planted trees on the chief highways would reflect great credit on the State and communities which made such planting a reality. Many States take well merited pride in their public roads. Invariably fine trees, either native or planted, are

found along these roads and it is considered criminal to injure or destroy them. We are beginning to consider the value of fine roadside trees in Texas, and every effort should be made to stimulate an interest in this phase of planting.

WINDBREAKS AND SHELTERBELTS.

Protection planting has a recognized value wherever crops, buildings, soils or stock are exposed to unfavorable climatic conditions. In regions of little rainfall windbreaks or shelterbelts, by reducing evaporation, prevent loss of plant and soil moisture. In sections of Kansas, Nebraska, Iowa and other prairie States the windbreak is an important part of the arrangement of crop areas on the farms. In Harvey county, Kansas, there are 170 miles of osage orange rows. One township in Platte county, Nebraska, contains 22 miles of rows, belts and groves of windbreaks, mostly cottonwood. York county, Nebraska, has 40 miles of windbreaks in one township, and Fairbault county, Minnesota, supports 400 acres of cottonwood and willow shelterbelts in one township. In Oregon, Lombardy poplars are extensively planted for orchard windbreaks. In Texas, particularly on the plains of the western counties, practically the same conditions affecting agricultural operations are encountered as in the Middle Western States just mentioned. In this part of our State planting trees for protection purposes is economically desirable. In the stock raising sections the value of protection planting should be recognized. Shade in summer is an asset to the beef grower. In winter stock can be brought through in better flesh on less feed if protected from the cold, biting winds.

Many far-sighted farmers in our State are alive to these considerations. In South Texas windbreaks have been planted in Willacy county to protect citrus groves, and in Brooks, Aransas and Cameron counties to protect diversified farm crops. In the Panhandle groves and rows of trees have been planted in Ochiltree, Roberts, Hemphill, Gray, Swisher and doubtless many other counties to protect crops and soils on the windswept plains. When the value of shelterbelts is more generally known, protection planting will become a definite part of the plan of management on every well conducted prairie farm.

INFLUENCES OF WINDBREAKS AND SHELTERBELTS.

The injurious effects of air currents increase or decrease with their velocity. Shelterbelts, by decreasing the velocity of air currents striking them, exert a beneficial influence over adjacent areas, the degree of protection varying with the height and density of the windbreak. Height determines the distance to which the protection is felt. Investigations have shown that the protected area extends approximately five times the height to windward and fifteen times the height to leeward of the windbreak. Density controls the relative amounts of air which leak through rather than are deflected upward and over the windbreak.

During dry periods shelterbelts check the drying out of crop plants themselves and by decreasing soil evaporation automatically increase

the supply of available soil moisture over the protected area. Crop yields are thus increased. Investigations by the United States Forest Service show that yields on protected areas have been increased 35 per cent above normal. In one instance a well protected field of corn made a net gain above normal yield equivalent to the product from an area as long as the windbreak and twice as wide as the height of the trees. Statistics further show that areas protected by windbreaks have produced crops under the most severe growing conditions when crops on unprotected areas under the same conditions were failures. When high winds occur shelterbelts prevent breakage of crops and orchard trees as well as the burying of field crops under loose, fine soils which may be transported by the wind. The protection afforded stock has already been mentioned.

The wood products obtained from thinnings made in the windbreak are further advantages which should not be overlooked. It is obvious the cuttings cannot be made too heavy, but with care the windbreak can be made to furnish a large part, if not all, of the material used on the farm.

Ranch buildings are made more habitable when protected from the blasts of hot and cold winds. A quite intangible, but none the less real, value of the windbreak is the æsthetic one. Who can estimate the value of personal comfort and satisfaction? It must be conceded, however, that the value of a farm supporting the proper growth of trees is greater than that of a similar farm barren of tree growth.

Certain slight disadvantages are incident to windbreak planting, but they are negligible when compared to the advantages. The windbreak must be located where it will furnish the maximum protection and it is thus necessary to use soil areas which could be planted to crops. In this connection the windbreak should be regarded as crop insurance and in those sections where protection planting is necessary 10 per cent of the farm area might well be devoted to windbreaks in view of the protection and increased crop returns secured on the remaining 90 per cent.

As a result of shading, coupled with competition between the roots of the trees and the crop plants for food and moisture, there is a loss in yield on the strip of land immediately adjoining the windbreak. This slight loss is more than offset by increased returns from the remainder of the protected area. It can be further lessened by wise selection of the trees, the direction of the windbreak itself and by proper handling afterwards. Do not plant trees that have wide-spreading crowns or rambling root systems. Cultivation conserves the available soil moisture and consequently restricts the spread of the roots in their search for food. A ditch dug on the field side of the windbreak a reasonable distance from the base of the trees will effectually stop the spread of the roots in that direction.

ARRANGEMENT AND LOCATION OF WINDBREAKS.

Three types of windbreaks are generally recognized: single rows of trees, belts composed of two or more rows and groves of trees in natural

arrangement. The belt and grove types, since they are denser, are more efficient than single rows of trees. Four parallel rows make an excellent windbreak. Several rows of shrubs planted on the windward side of the main windbreak will further increase its efficiency by deflecting air currents upward before they reach the trees. If the windbreak is composed of hardwoods it may be made denser by underplanting with conifers or shrubs. A belt type of windbreak composed of three rows of shrubs and four rows of trees, spaced three feet and eight feet, respectively, would be thirty-three feet wide and were the windbreak one-half mile long the total area occupied would be two acres.

The location of the windbreak should, in all cases, depend on the arrangement of the crop areas, the direction of the prevailing winds and the topography of the area to be protected. Locate the windbreak on the windward side of crop areas and at right angles, or nearly so, to the prevailing winds. The windbreak should always be on the higher elevations and never in the bottoms. In this State, since southwest winds prevail in those sections where shelterbelts are most needed, the planting should generally be made along the south and west boundaries of the farm. If the area to be protected is a large one it may be advisable to plant cross belts inside the boundaries to supplement the main windbreaks. Single rows of trees may be planted for cross belts, but in all cases, in this State, the belts should be laid out east and west to reduce shading and secure maximum protection. Because of the zone of relatively still air currents to leeward of a windbreak it should not be located within one hundred feet of the buildings.

Hedgerows are not a substitute for windbreaks or shelterbelts. They provide shelter from insects and rodents and because of their relatively low height the expense of planting is out of all proportion to the protection afforded. Finally, their heavy root system, due to the unbroken line of vegetation, saps the soil of food material which the crop plants need.

FENCE POSTS AND FUEL.

Over the greater portion of Texas every farmer should be concerned with the problem of growing at least part of his home wood supply. Vast areas are practically treeless. Thirty-two counties in West and Northwest Texas with a total area of 22,550,000 acres have 62 per cent of their area in improved and unimproved farms, but only a little more than three-fifths of 1 per cent (8,532 acres) of the farm land is wooded. The United States Forest Service* estimates that 2,500,000 acres in the prairie and plains sections of Texas should be devoted to woodlot planting in order to preserve the balance between woodland and farm. Eight Panhandle counties in which approximately 100 per cent of the entire area (5,100,000 acres) is farm land are wooded to the extent of less than seven one-hundredths of 1 per cent (3,468 acres) of their entire area. That wooded areas do not interfere with the best agricultural development is shown in the Black Prairie section of the State, where

*Year book of the U. S. Department of Agriculture, 1909.

ten counties with approximately 74 per cent of their total area (5,800,000 acres) in farm land, 58 per cent of which is improved, devote more than 18.9 per cent (808,862 acres) of the farm area to woodlots.

It is in the nearly treeless sections that the demand for wood products becomes a pressing problem and where woodlot planting would be a material help to every farmer. Local prices for wood are usually excessive. Fence posts and fuel are rapidly becoming more expensive and difficult to secure. The woodlot can furnish such material; even larger sized trees if time is allowed for them to grow. Farm soils are not so valuable that an acre, or a few acres, cannot be devoted to the woodlot. A well-to-do farmer can easily afford to maintain a woodlot and a poor farmer cannot afford to lose the benefits to be derived from one. Difficulties encountered in planting and maturing the woodlot in those sections where they are most needed are no argument against planting them. Proper care in the initial planting and cultivation afterwards will insure the success of the undertaking.

No soils are too poor in plant food to support a tree. On every farm are areas which cannot be profitably used for growing crops. A woodlot on the farm means more acres producing revenue and fewer idle acres. Plant the corners, the rocky areas and those places where erosion will result if the land is not protected. Material benefits may be derived from the woodlot as well as from the garden and orchard. The woodlot, if properly located, will furnish protection to stock and buildings. It can be made to yield a direct financial revenue. Figures are not available from woodlots planted in Texas, but the profits realized in other States are shown under the paragraph headed "Profit from Planting."

THE USE OF WILD AND NURSERY GROWN STOCK.

It has been pointed out that wild stock is the common source of supply where native trees are found in abundance. In many of the smaller towns nursery grown trees have scarcely ever been used. There is a tendency, however, to recognize the better quality of trees grown in nurseries and as a result commercial dealers are being called upon to supply the trees for much of the city planting today. It would be unjust to criticize the use of wild stock, but it is fair to say that the objections to its use lie chiefly in the methods of digging and handling the trees for transplanting purposes and in the large size of the trees so generally used. It is important that trees not over two and one-half inches in diameter one foot from the ground be used and that as much of the root system as possible is secured. If the planting can be done carefully and the roots not allowed to dry out during the operation of transplanting, much better results with the use of wild stock may be obtained. Trees growing in the open are preferable to those taken from shady places. The stems should be straight and free from forks or branches near the ground. The top must, of course, be somewhat reduced before planting in order to conform to the diminished root system. In most situations, however, it is undoubtedly a mistake



TYPICAL STREET IN A SMALL CITY WELL PLANTED WITH HACKBERRY AND PECAN.



A STREET WHICH SHOWS LACK OF UNIFORMITY IN PLANTING.
(Note the care with which the native oak has been preserved.)

to cut back the top to a bare pole, especially if care has been exercised to secure good roots.

Nursery grown trees are generally free from the objectionable features common to wild trees and have a much better chance to survive and grow rapidly after planting. If one has not the time to grow stock from seed at home and is unable to secure satisfactory stock from the woods it may be purchased from reliable nursery dealers. The chance of failure is lessened if planting stock is ordered from nearby dealers as long shipping distances are avoided. A few nursery dealers in Texas advertise stock in lots of one thousand at very reasonable prices, but most nurserymen are not as yet prepared to furnish trees for woodlot and windbreak planting at sufficiently low prices to interest prospective planters. As interest in planting increases, however, and there is a larger demand for the better quality of trees grown in nurseries it is certain that dealers will not only grow the stock to meet this demand, but that prices will be low enough to enable the planter to buy trees in lots of one thousand rather than by the dozen or single trees. Further information regarding the location of commercial nurseries and their prices for stock will be furnished upon request.

GROWING NURSERY STOCK AT HOME.

Cultivated stock, since it is grown under the most favorable conditions, is hardier than wild stock, free from disease, insect injuries and wounds, and the crown and root system have been forced into more compact form. All these characteristics insure thrifty growth even with unfavorable soil and moisture conditions. The prospective planter who desires to grow planting stock at home can do so on a small scale without difficulty and at much less expense than the stock can be purchased from commercial nurseries. Seed for planting may be purchased from reputable seed dealers or collected locally in the fall, which is the time when the seed of most tree species ripens. Seed which is wormy, mouldy or light in weight should always be rejected. In storing seed over winter it is well to remember that seeds which remain on the trees until spring should be sacked and kept in a cool, dry place. On the other hand, seed which lays on the ground over winter is best stored between layers of earth in a cool, moist condition or else planted at once. If seed is to be purchased from dealers it should be ordered early, thus enabling the dealer to plan ahead on filling the order or to notify the planter if he cannot supply the seed. Seed collected in one region for planting in another with widely different climatic conditions may give poor results.

THE NURSERY.

Nursery soil should be loose, fresh and free from weeds. The best site for a small home nursery is a well drained and cultivated portion of the garden. Nuts and other large seeds may be planted in long rows in the fall or early spring. With this exception it is better to plant the seed in the early spring in beds about four by twelve feet.

Beds of this size are easy to handle and the germination of small seeds is better secured. If several beds are to be planted, paths two feet wide between the beds and several inches below their general level will facilitate access to the nursery and give better drainage. The seed should be planted in drills to a depth of two or three times their thickness. Coniferous seeds are frequently sown broadcast in the beds and lightly covered with soil. Hard coated seeds, like black locust, can be made to germinate quicker by soaking them in warm water before planting. After planting the seeds the beds should be watered and mulched to prevent subsequent drying out, but as soon as the young trees make their appearance above ground the mulch should be removed. Lath frames supported on posts are considered absolutely essential, particularly with conifers, in order to furnish partial shade after germination. The sides are often enclosed with boards to prevent unnecessary drying of the soil. In well ordered nurseries the beds are also screened to keep rodents and birds from eating the seed before germination and the young seedlings afterwards. During the first growing season it is necessary to keep the beds well weeded and occasionally watered to prevent the ground from becoming dry.

In order to secure a more compact and fibrous root system, which will better enable the trees to survive when they are planted in the final site, all seedlings should be transplanted to rows in the nursery for at least one additional year. Seedlings of most hardwood or broad-leaved species are transplanted at the end of the first growing season; conifers should preferably remain in the seed beds two years. When taking the seedlings from the beds care should be exercised to thoroughly loosen the soil so as to prevent all possible damage to the roots. Unusually long roots, together with part of the crown, should be cut back except with conifers, and these should never be pruned. Transplanting should be done on cloudy days, always bearing in mind that the roots of the seedlings must be kept moist during the operation. The spacing in the transplant rows will depend somewhat on the area available, but four-foot rows with the trees two feet apart in the rows will permit of horse cultivation and allow sufficient space for growth during the year. At the end of the second year the trees may be root pruned in the rows, again transplanted or set out in the permanent plantation if they are of suitable size.

PLANTING THE TREES.

In Texas planting between late fall and the first of February gives the young trees the best chance to become established. If the planting is done before or during a rainy period the young trees are far better prepared to survive the dry spells which may follow in the early spring. For this reason it is unquestionably true that the present date of Arbor Day (February 22) is too late for the tree planter to secure the best results.

The roots of the young trees should be kept moist from the time they leave the nursery, or are dug in the woods, until they are finally planted.

While this rule applies to all trees, success in planting conifers particularly depends on keeping the roots moist. Most nursery dealers will ship coniferous trees only with balls of earth and well wrapped in burlap. In general the roots may be kept moist by covering them with wet burlap or moss; small seedlings may have their roots immersed in a bucket of water or thin mud. To avoid delay the planting site should, of course, be prepared in advance of the planting. The conditions under which the planting is to be done should determine the kind and size of trees used. Street and yard trees may be larger and of wider variety than those for windbreak or woodlot planting.

STREET AND YARD TREES.

On city streets use stock that has been transplanted one or more times. Such trees are better able to stand removal to the unfavorable surroundings usually found on city streets. Trees having a diameter of one and one-half to two inches one foot from the ground are best, since they are not too large to readily establish themselves and yet are large enough to insure satisfactory development after planting. They should have straight stems and be free from forks and crooks. The height at which the crown should begin depends upon the traffic where the tree is planted; eight feet is usually considered standard. The tree should be free from disease, insects and wounds.

The size of the openings in which the trees are to be planted depends on the size of the trees and the character of the soil in the planting site. The hole should afford ample growing space to allow the roots to spread. In compact, clayey soils the opening is necessarily larger than would be required in loose, porous soils. A good rule is to make the tree pit at least twice as wide and twice as deep as the root system of the tree to be planted. In some cities, where tree planting is carried on systematically, the openings are made six feet long, three feet wide and three feet deep. To furnish food for the young tree during the early stages of its growth enough fresh, new soil to half fill the tree pit should be on hand before the planting.

In order to preserve the necessary balance between the roots and the crown the young tree should be pruned before setting and all bruised and broken parts removed from the roots. Use sharp tools in pruning, as ragged wounds are slow to heal and cut side branches directly above strong, healthy buds. The roots of the tree, arranged in their natural position, are placed in contact with the new soil which has previously been spread in the bottom of the pit. With the tree held upright in the pit the rest of the new soil is thrown in around the roots and tamped closely and firmly about them. No air spaces should be left around the roots and no leaves, twigs or other vegetable matter should come in contact with them. The remaining soil is then thrown into the pit and tamped frequently, but the final layer of soil should be left loose to act as a mulch. As each layer of soil is tamped during the planting it should be moistened but not made too wet.

A stake, or, better still, two of them, should be set alongside the

young tree to furnish support and hold it upright in the ground. This may be done by wrapping a piece of common garden hose, through which a wire has been run, around the trunk and attaching the ends of the wire to the tops of the supports. After the tree has been planted and staked a wire netting, close meshed chicken wire will answer, may be placed around the trunk to protect the tree from mechanical injuries incident to street traffic.

The width of spacing between the trees in street planting depends upon the species planted and the local conditions. Some species need more room for crown and root expansion than others. The space available for planting, the cost and various other factors must also be considered. For most city planting under average conditions a spacing of 30 to 35 feet apart is considered standard.

In planting trees in yards or similar situations where growing conditions are less severe than in street planting the size of the planting stock is relatively unimportant and the trees may be smaller or larger than is necessary for street planting. Transplanted trees, however, will respond more quickly, grow faster and give the best results. Conifers should in general be used only for yard planting in this State and stock three or more years old and at least one transplanted should always be selected. Hardwoods, when used for yard planting, should be two or more years old but should not be larger than three inches in diameter one foot from the ground unless unusual precautions are taken in planting.

SHELTERBELT AND WOODLOT PLANTING.

In both these types of planting the trees used should be smaller than for street and yard planting. Small trees are better able to stand the shock of transplanting and the labor and expense of planting are lessened. When planting hardwoods use trees from eighteen to thirty inches in height and for conifers use transplanted trees approximately twenty-four inches in height. The planting of seeds directly in the final site is not advocated since experience has shown that good results are seldom secured by this method.

Previous and careful preparation of the planting site is essential for the best results. Deep plowing during the previous May or June, followed by surface cultivation during the rest of the growing season, will keep down the growth of grass and weeds and help to conserve the soil moisture. Such preparation also insures a soil, free from coarse material, which will pack closely around the roots of the trees. Sod bound or clayey, compact soils with an impervious subsoil should be deeply plowed two years before the planting and the sod or heavy soil worked down. Such treatment kills out the native grasses and renders the soil loose and porous. Splendid results have been obtained by plowing under and disking a cover crop of cowpeas previously grown on the planting site.

Two methods of setting out the trees may be used: plow or hole planting. Planting with a plow is the cheapest and quickest method if the

trees are sufficiently small and a large number are to be planted. Lay out the tree rows, marking them along their length and at each end by stakes. Plow down the row and deepen this furrow by plowing back again, the finished furrow then being eight to twelve inches in depth. Hold the tree by its top, the roots being in the bottom of the furrow, and plant by pulling the soil in from the sides and tamping it firmly around the roots with the feet. When the planting is complete the trees should be upright in the rows and about one inch deeper in the ground than they grew in the nursery. The entire length of the furrow is then filled level with the surrounding surface. No hills or ridges should be left along the rows. It is advisable to plow only one or two furrows at a time as the soil dries out quickly and in such condition is injurious or fatal to the young trees.

Planting in holes is the best method if the trees are of fairly large size, the growing conditions are unfavorable or there are not many trees to be planted. Make the hole large enough to accommodate the entire root system of the tree. Set the tree upright in the hole, taking care to spread out the roots. Fill the soil in around the roots and tamp firmly with the feet. To finish the planting it may be advisable to water each tree after it has been set.

In shelterbelt and woodlot planting the spacing of the trees is governed by the purpose for which the planting is made. For shelterbelts, since density is the main requisite, four-foot spacing in the rows with the rows eight feet apart is good practice. This spacing between the rows, while wide enough to permit of easy cultivation, will also force height growth, shorten the time necessary for the crowns to close and automatically help to check the growth of weeds and grass. Where rainfall is insufficient a spacing of eight feet each way admits of cross cultivation and has given satisfactory results.

For fence post planting the trees may be spaced four feet apart in the rows with the rows six feet apart. This somewhat closer spacing forces height growth and produces the straighter, cleaner stems desired in fence post trees and at the same time admits of cultivation. Under extremely dry land conditions a wider spacing is perhaps desirable or else thinnings should be made earlier in the life of the plantation.

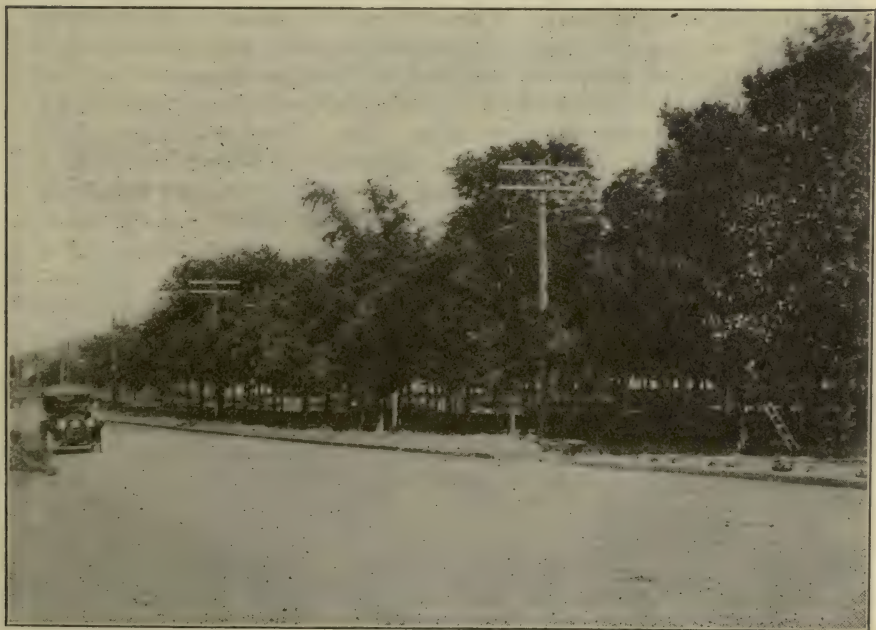
When planting for fuel the spacing may be wider than for either of the types mentioned. In a fuel wood plantation the form of the tree is not so important as the production of wood, and wider spacing makes for spreading crowns, rapid growth and a consequently higher yield in wood.

SPECIES FOR PLANTING.

When selecting tree species for planting in Texas the State should be considered by sections rather than as a whole. Factors of soil and climate vary so widely that trees entirely suitable to one region may fail in another. In East Texas growing conditions are unusually favorable and most of the tree species found in the eastern and northern States may be grown. Farther west more compact soils, less rainfall, drying winds with increased evaporation and more intense sunlight



BARREN APPEARANCE OF A PLAINS FARM WITHOUT TREES.



A SMALL TRACT PLANTED WITH TREES AND RECENTLY DONATED TO A CITY FOR PARK PURPOSES.

tend to limit the choice of species. On the northwestern plains cold winters are encountered, and the number of trees adapted to the region is still further reduced as they must resist all other unfavorable conditions and also be frost hardy. Nevertheless, where soils are cultivated and the trees watered during early life a wide range of species is available for planting throughout the Panhandle country. In South Texas the selection tends toward thin foliaged types of semi-tropical trees. Palms and trees of the bean family are prominent, although species from all sections thrive when given proper care.

STREET AND YARD TREES.

In this type of planting local climatic conditions are not so important as in windbreak or woodlot planting since the trees may be and generally are given better care. The main factors governing the choice of species are length of life, rate of growth, strength of the wood, resistance to insect attacks and disease and the ultimate form of the tree. It is probably true that a larger variety of trees can be found growing along the streets and in the home grounds in Texas as a whole than in almost any other State in the country. This is because Texas is the natural meeting ground for species from the northern and eastern States and from Mexico. One has only to examine local tree planting anywhere, except in western Texas, to find a surprisingly large number of species in a thrifty condition.

In the Panhandle counties black locust represents at least 90 per cent of the species planted. In spite of this fact many other species grow well and should be more generally considered. Among those which have been examined and which should be more extensively planted are Russian wild olive, silver maple, box elder, western cottonwood, green ash, silver poplar, thornless honey locust, Japanese privet, American elm, osage orange (Bois d'Arc), salt cedar, Oriental arbor vitae, Texas umbrella, red cedar and the willows and mulberries. Lombardy poplar is much planted but is apt to become unsightly after a period of years. Catalpa does not make a good tree on the high plains. A few specimens of hackberry are found but they lack the vigor and beauty of these trees as grown east of the breaks in the plains. The pecan seems to grow extremely slowly but should be more carefully tested out. Several of the pines, such as western yellow, Corsican, Scotch and others are grown, and they are worthy of consideration for yard purposes. This is also true of a number of cedars and several varieties of cypress. *Cedrus deodora* gives promise of being a splendid ornamental tree. There are many others which it is hoped will be tried out in the near future.

In southwestern Texas, where rainfall is entirely inadequate for good tree growth and where alkaline soils must be considered, black locust, western cottonwood and salt cedar appear to thrive. In Pecos even the business streets are lined with salt cedars, and the appearance is most attractive. This tree has actually escaped to waste areas where it is growing in thickets. Of the two varieties of salt cedar the plumosa

is the more desirable. Where the trees are well watered the wild olive, umbrella China, Japanese persimmon, mulberries and many others are growing well.

In the region south of San Antonio along the Gulf coast species of semi-tropical character make their appearance and are successfully cultivated. Eucalyptus is grown in San Antonio, although it is not frost hardy so far north. Oleander, pomegranate, yucca, various species of palmetto, camphor tree, olive, huisache, mesquite, horse-bean, loquat and various kinds of citrus trees are grown for street and yard purposes. To these are added the hackberry, catalpa, Russian, red and paper mulberries, box elder, silver maple, sycamore, Chinese arbor vitae, black and English walnuts, pecan, live oak and other species in abundance commonly found in other parts of Texas. A number of trees like camphor and the citrus varieties are not hardy far from the coast. In Corpus Christi one finds the salt cedar grown as arbors to shade walks and grounds. Farther inland mesquite and huisache are used extensively for the streets and yards and with occasional watering and pruning they make most desirable shade trees.

In central and eastern Texas the number of species grown for shade and ornament becomes almost unlimited. Among the best and most permanent of these for streets and yards are the sycamore, water oak (known as pin oak), Texas red oak, live oak, English elm, American elm, pecan and hackberry. There are many others which might be included, but observations show that these represent perhaps the best in our street planting over a wide area. European sycamore should be as good as the native species so commonly used.

The pecan should be far more extensively planted, both as a street and yard tree. It furnishes both shade and fruit, grows well in moist situations and makes a tree which will endure for centuries. Such trees as hackberry, chinaberry, especially the variety known as Texas umbrella, osage orange (Bois d'Arc), red cedar, arbor vitae, ash, elm and locust have contributed more to the beauty of our streets and grounds than other trees as they have been more extensively planted. In some central Texas cities, like LaGrange and San Saba, native live oaks of remarkable size and form are found along the streets as well as in private grounds. In other towns and cities through the prairie belts hackberry and American elm have been almost exclusively planted, but in many places the too extensive planting of hackberry has proved unwise and more recent planting consists of elm and sycamore. On many of the newer streets in cities sycamore is exclusively used.

In the eastern counties many trees such as the hackberry and the live oak give way to trees more common to the southeastern Atlantic States. Here one finds the tulip, sweet gum, linden, post, overcup, Spanish, water and basket oaks, magnolia and black gum. Of course elms, sycamore and ash are widely used. Along the southeastern Gulf Coast semi-tropical trees predominate. Palms and camphor trees add much to the beauty of Orange, Beaumont and Galveston.

In the impervious soil of the post oak section, north and south from College Station, although within the range of a vast number of tree

species, many have failed to grow as well as do those in sections to the west and east. However, there are fine examples on the campus of the Agricultural and Mechanical College and in neighboring towns of live, water, red, overcup, burr and other oaks, bald cypress and pecan, as well as trees from other sections of this country and abroad. Among the most interesting of these are cork oak, *Cedrus deodora*, Lawson cypress, and Japanese varnish. The most common trees through this section are hackberry, American and cedar elms, post oak and red cedar.

Many trees which have not as yet been tried or the success of which has not been fully demonstrated may in the future prove to be desirable. It is not possible in this bulletin to discuss species for an area as large as Texas and do justice to many trees which are undoubtedly adaptable to one region or another.

WINDBREAK AND WOODLOT TREES.

The main requisites in a species for windbreak planting are long life, density of foliage and compactness of crown and root system. Since the windbreak may be cultivated, thus conserving the available soil moisture, the choice of species is fairly wide. Honey locust (the thornless variety is easier cultivated), osage orange, Russian wild olive, green ash, American elm, Russian golden willow and cottonwood are commonly used. If conifers are desired one may plant Austrian pine, Scotch pine, Chinese arbor vitae and a number of cedars. Red cedar should not be planted around orchards since this tree is a host plant for a transition stage (cedar apple) in the life of a fungus attacking fruit trees. A row of Russian mulberries or osage orange trees is frequently used as a preliminary planting on the windward side of a windbreak.

For fence post planting the species selected should combine durability of the wood in contact with the ground with comparatively rapid growth. Durability, however, in view of the present methods of treating posts to prevent decay is becoming less important. The black locust, in regions where the locust borer is not a menace, honey locust, osage orange, Russian mulberry and hardy catalpa, where soils are rich and considerable moisture is available, are among the best of the hardwoods for fence post plantations. Of the conifers, Chinese arbor vitae and red cedar may be planted. If it is the purpose to treat the posts before setting them one may include green ash, cottonwood, silver maple and elm in the list.

For woodlot planting adaptability to local growing conditions is the primary factor in choosing the species. A plantation established for fence post production will yield fuel wood as a by-product of the necessary thinnings, but should one plant for fuel alone, the cottonwood, green ash and black locust are comparatively fast growing and among the best which can be used.

CARE OF TREES AFTER PLANTING.

Failure too often results through lack of systematic care after planting. The trees have been transferred to a totally different environ-

ment in which the factors affecting growth are usually unfavorable, particularly during the early life of the trees. Shade trees should, therefore, be watered frequently. Street trees, in particular, suffer from lack of moisture because the surrounding surface is usually paved and the water falling on such a surface may not reach the soil at all. Even should an opening be left around the base of the tree constant trampling will so compact the soil as to render it impervious to moisture.

It is important to remember that a tree needs water not directly around the base but farther out where the feeding roots are located. Lawn trees should be watered at a distance from the base equal to the spread of the crown as most of the feeding roots are located under the "drip" of the branches. Since a street tree cannot be watered so far out from the trunk, one should loosen the soil around the base, make a circular trench or a number of small pits in this loose soil as far out as possible and slowly pour as much water into the depressions as the soil will take up. At all times the top soil should be loose to act as a mulch. Sometimes single tile pipes are set on end in the ground, or sub-irrigation systems are installed when the trees are planted, to facilitate watering. More water is necessary directly after the planting and during the several seasons immediately following while the young trees are becoming established. In general, a young tree requires twenty to twenty-five gallons at each watering; older trees require more. Fewer waterings are necessary if the soil around the base of the tree is kept free from grass and weeds and carefully cultivated.

In the windbreak or woodlot plantation it is not practicable to water individual trees. For this reason the plantation should be well cultivated directly after the planting and at frequent subsequent intervals. Cultivation makes the soil porous and capable of quickly absorbing moisture and checking evaporation. Hard, baked soils not only dry out quickly but often injure small trees by cutting the bark when the trunks move against the surrounding collar of soil. Cultivation should not be continued too late in the fall as there is danger of forcing new growth which an early frost will kill back.

As a tree grows older the roots and branches tend to maintain an equal balance. It often happens, however, that the root systems of shade trees are diminished by reason of excavations or the crowns become too large for the space that the trees may occupy and pruning becomes necessary. Severe pruning should be done in the winter or late fall when the trees are dormant. The crowns can be kept symmetrical and there is less danger of pruning too heavily if the cutting starts at the top and proceeds downward. Do not remove all the side branches at one time as this not only weakens the tree by depriving it of too much of the leaf surface, but there is the added danger of girdling the tree, particularly a small one. The side branches should be cut directly above strong, healthy buds. In removing limbs make all cuts parallel with and as close to the main stem as possible. The exposed surfaces of the wood should be covered with an antiseptic, waterproof dressing to prevent the entrance of insects and fungi. An application of creosote, followed by a coat of coal-tar, is an excellent dress-

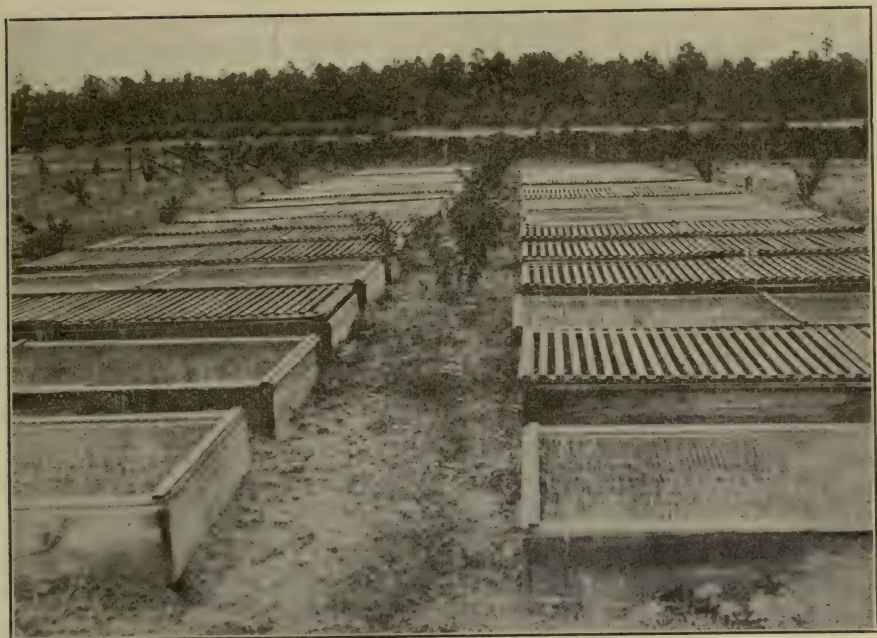
ing for tree wounds. Liquid asphaltum, and preparations containing it, are also efficient dressings, but they must be applied when hot. A good grade of heavy lead paint will be found to give good results. In any event the dressing must be renewed from time to time if checking, due to the drying out of the wounded tissue, exposes the wood surface.

In a plantation the trees will prune themselves to a limited extent, but some species when planted for fence post material should be artificially pruned in order to secure clear stems. One may remove side branches to the desired height but care should be exercised to make the cuts clean and not to prune so heavily that the future growth of the tree is lessened. In a shelterbelt the trees should not be pruned, as density is the main requisite. Sprouts should be removed from the base of a tree in any type of plantation.

Street trees are particularly liable to outside injuries. Such injuries when caused by horse bites, vehicles or any outside influence may be prevented by surrounding the tree with a suitable guard of wire, wood or iron. In many cities iron gratings are placed over the openings at the base of the trees to prevent injury by continual trampling of the soil. Overhead wiring often rubs the limbs and causes serious injury both by bark abrasions and the effect of electric currents. A strip of wood placed on the limb at the point of contact will prevent such injury. Raising or lowering grades around established trees will probably result in their death by diminishing the supply of water and air or by exposure. When filling around trees use rocks for the first few layers and then cover these with soil or else build up a wall around the trees, leaving an air space of a foot or more between. When grades are lowered there is probably no remedy except the replanting of such trees as are not too large. Gas from leaking mains will soon impregnate the soil around the roots and kill most trees. By stopping the leak, removing the gas saturated soil and replacing it with fresh material the tree may be saved if the injury is not too serious.

When parts of a tree are diseased or wounded reasonable tree repair is justified provided the value of the tree warrants the expense. Wounds should be creosoted and tarred, but diseased portions of the tree should be thoroughly cleaned and filled with cement or asphaltum. Each serious case usually demands a distinct method of handling and for this reason one should avoid fakers and never trust the future welfare of his tree to any but competent operators.

Insect and fungus enemies are everywhere present and constant watchfulness is necessary to protect the trees. Since fungi gain entrance principally through wounded surfaces protecting the trees from outside injuries will generally prevent this trouble. Insects present a more difficult problem. The insect enemies of a tree may be grouped into three general divisions—the leaf eaters, the sucking insects and the wood borers—and because of their entirely different feeding habits each group requires special methods of control. The time when the insect is most vulnerable usually differs for each group and further complicates the situation. In general, spraying with an arsenate of lead solution (one pound to ten gallons of water) will effectually control leaf



SEED BEDS IN THE FOREST NURSERY AT THE TROUP EXPERIMENT STATION
 (Five to eight thousand seedlings germinate in one of these beds—4x12 feet.)



GARDEN PROTECTED BY A WINDBREAK IN THE PLAINS REGION.

eating insects, but for sucking insects one must use soap or oil solutions which will clog the breathing pores.

Wood borers work beneath the surface and cannot be reached by spraying, but must be removed from the bark by digging them out or killed by filling the galleries with carbon bisulphid and then plugging up the entrances. Whitewashing the trees for protection against boring insects is common practice throughout the State. There has been very little investigation to determine whether this treatment is effective or not. When applied to young, thin-barked trees or to the smaller branches of any tree there is danger that whitewash will clog the breathing pores of the bark and cause a distinct injury. The city of Chicago recognizes this possible injurious effect and has prohibited, by ordinance, the whitewashing of city trees. As a further means of keeping these breathing pores open it is advisable to wash down the leaves, branches and trunk of a tree at frequent intervals in order to remove clogging particles of dust. The whitewashing of large trunks and thick-barked trees can do no possible injury and may be effective against borers.

The State Entomologist, at College Station, will gladly furnish information and answer inquiries concerning insect control upon request.

PROFIT FROM PLANTING.

Although direct financial returns through the sale of wood products cannot be derived from trees planted for shade or ornamental purposes there yet exists a definite value in many forms. Building sites are influenced by the presence or absence of appropriate tree growth. Trees planted for shade and landscape effects unquestionably increase real estate values.

In addition to such tangible results the sentimental or aesthetic value of the trees must be considered. One can scarcely estimate the value of a tree which has furnished shade and stood as an object of beauty for many years. Yet a value is recognized and fine old trees are often saved by building around them when improvements are made. Nor can one fix a value on the effect of tree growth in the health and everyday living conditions of a community. Statistics show that mortality figures rise during the hot months of the year and that trees, by giving off oxygen and moisture from the leaves, lower the temperature, purify the atmosphere and promote the general welfare of the community. Where the public highways of the State and the streets of cities and towns are planted with trees it is impossible to estimate in dollars and cents the prestige and recognition accruing to the commonwealth fortunate enough to possess them.

Various standards of appraisal have been devised to apply to shade trees. The "Parker Standard," probably the best of them, gives a rating of 100 per cent to a tree which is perfect in position, species, trunk condition, top condition, general desirability and scenic value. Reductions on a percentage basis are made for defects under these headings and the resultant figures totaled. This percentage rating of the

tree is then multiplied by a basal area valuation of \$1 per square inch and the product is the value of the tree. By this means it is entirely possible to assign a definite value to a shade or ornamental tree. One of the eastern States has calculated by this method that healthy, well formed trees two inches in diameter at breast height are worth \$3, and this value increases with diameter until a tree sixteen inches or over is worth \$100 or more. At this valuation, which has been upheld in courts of law, one can readily see that shade trees are good investments. City trees also, unlike most other civic improvements, do not depreciate for a long period of years, but under proper care and at little expense increase in value with age.

Profits in woodlot planting are derived from the sale of wood products and vary in amount according to the species planted, the care given the growing trees and the length of time elapsing before the timber is marketed. With selected species and proper methods of management it is possible to grow fence post material in fifteen years or less in this State. Larger material would require a proportionately longer time. A few figures showing returns from actual plantations in different prairie States may be used to indicate what may be expected. In eastern Nebraska* a twenty-one-year-old green ash plantation yielded a gross revenue of \$148 per acre on an investment of \$39.17. An osage orange plantation produced \$381.20 revenue from the sale of posts and poles on an investment of \$90.25 in thirty-two years. Honey locust during a period of twenty-nine years produced a gross income of \$193.43 on an investment of \$60.50. All these figures are on an acreage basis and compound interest at 5 per cent is included in the figures of cost. The gross returns could have been increased under better methods of management. In Reno county, Kansas, on the well known Yaggy catalpa plantation,† the trees after ten years, under the best methods of initial planting and subsequent management, have yielded an annual return of \$19.75 per acre. These returns are low when compared to the yield of cultivated field crops, but in view of the benefits and conveniences derived from a small woodlot such planting is amply justified.

The principal value of windbreak planting lies in the beneficial effects upon crops grown on the protected areas. Figures of increased yield as a direct result of the protection afforded by the shelterbelt have already been shown. Their beneficial effect on stock and ranch buildings has also been mentioned. These are to a certain extent intangible values but the product of the thinnings made in the windbreak are a source of direct financial return and must not be disregarded.

CITY FORESTRY.

Cities, both large and small and in all sections of the country, are awake to the necessity for systematic management of their street trees and as a result a new field of work has been created—city forestry. City forestry concerns itself with the establishment of municipal nurs-

*United States Department of Agriculture, Forest Service Circular No. 45.

†Kansas Experiment Station Bulletin No. 108.

eries, the selection of suitable species for planting and the proper methods of setting out, pruning, spraying or removing trees within the city. The scope of the work is both technical and administrative since it deals with the management of the trees directly and also enforces city regulations necessary to secure the most effective results.

In many sections of the country, city forestry work is well established. New York, Washington, Baltimore, Jersey City, Newark, Rochester, Chicago, Minneapolis, St. Louis, Los Angeles and many other cities, both large and small, have inaugurated departments which carry out the local policy of handling street and park trees. Dallas has so far been the only city in our State to create the office of city forester, but the results already attained should encourage other of our larger cities to follow suit. Virginia, Minnesota, a small sawmill town, has only eleven miles of streets, but under the care and direction of the city forestry department has parked and transformed them into boulevards, in addition to establishing a forty-acre city park. In our own State the local tree club of Temple, by means of a recently completed street tree census, has ascertained that 30,496 trees, embracing forty-nine distinct species, are growing within the corporate limits. Clubs and organizations of this kind may result in street tree commissions or city forestry departments vested with proper authority in the handling of their trees.

A definite method of procedure should be followed in establishing city forestry work if the best results are to be secured. In large cities there should be one governing body, usually the park board, highway department or a specially organized street tree commission, which formulates the city's policy in handling the trees. This body and its appointees should be entirely free from city politics, as results are not secured at once and changes in management are not desirable. One city employe, appointed by and answerable to this body, should be placed in charge of the actual work and given the authority necessary to carry it on. He should be authorized, subject to the approval of the governing body, to employ the necessary assistants, to devise and improve city regulations incident to the proper conduct of the work and to regulate and control all matters pertaining to the care and propagation of the city's trees. He should endeavor to secure an accurate record of the location, condition, species and number of the city trees and should prepare an annual report setting forth the past year's activities with the results and a proposed plan for the ensuing year. In addition, he should be ready at all times to furnish advice as to insect control and private planting and should prepare timely press notices containing information which his public should know.

The head of the city forestry department is variously styled "City Forester," "Tree Warden," "City Arboriculturist" or "Superintendent of Trees," but under any title his duties are practically as outlined above. Because of the many different phases of the work a special training is required and forestry schools are educating men to fill this demand. An efficient city forester should be an executive. His technical qualifications should embrace a knowledge of botany, insects and fungus

diseases and methods for their control, the characteristics and growth habits of trees and shrubs and landscape architecture. As a further desirable qualification he must be willing to admit and adopt new methods, the worth of which has been proven.

Cities and towns of from 4,000 to 15,000 inhabitants, of which there are a large number in this State, may establish a medium for handling their street trees at little expense. Interested citizens in each town could organize a tree club which would have for its object the compilation of a census showing the number, species, condition and location of the town trees. With this information at hand interest could be developed and subscriptions taken for carrying the work further. Temple, Texas, as already stated, has organized such a tree club and made the preliminary census. Interest was aroused in the undertaking by offering prizes to those making the closest estimate of the actual number of trees and many residents co-operated in the counting and listing.

Whether a city forestry organization is established or not it is desirable for every city to make regulations to protect its trees. City trees are greatly handicapped by reason of their unnatural surroundings and should be properly handled and protected. City tree ordinances, beyond setting forth the personnel of the governing body and the manner of appointing and duties of the city forester, provide for regulating the planting, spraying, pruning or removal of all trees, whether publicly or privately owned, and generally place the control of all such work under a city forester through a system of permits. Such ordinances may specify the kind, size and manner of planting of all trees within the city limits and also provide for the assessment of property owners who are benefited as a result of city tree improvement work. In addition, and perhaps of more importance, the tree ordinances impose penalties for certain acts detrimental to the welfare of the trees and define those acts without chance of misunderstanding.

A sample set of ordinances covering the above points is as follows:

1. The board of (*insert name*) shall have full power and authority over all trees planted and to be planted in any of the streets or public places of the city, including the right to plant new trees and to care for the same, and to remove trees, living or dead, and to trim, spray and otherwise care for such trees.

2. The board of (*insert name*) is authorized to appoint a city forester and such other employes and assistants as may be necessary, and to prescribe and define their respective duties and to fix the amount of their compensation. Such forester shall be an expert, trained in the care and culture of trees.

3. The board of (*insert name*) shall recommend to the (*insert name of civic legislative body*) from time to time, ordinances to be enacted by the said (*insert name of civic legislative body*) for the planting, care and protection of trees in the streets and public places of the city; but no such ordinance not recommended by the said board shall be enacted by the (*insert name of civic legislative body*). Nor shall any ordinance enacted pursuant hereto be altered or repealed without the recommendation of said board.

4. The (*insert name of civic legislative body*) shall every year grant to the board of (*insert name*) such sum of money as it shall require and as to the said (*insert name of civic legislative body*) shall appear reasonable and just, for the planting, maintaining and caring for the trees of the city, for purchasing or raising new trees, and for other expenses contemplated by Sections 1, 2, 3 and 4 of this act.

5. No person shall, without the written permit of the board of (*insert name*) cut, remove, plant, break or injure any tree, plant or shrub in any of the streets or public places of the city of (*insert name*). Nor shall any person injure, misuse, or remove any device placed and intended to protect any tree, plant or shrub in any part of the streets or public places of the city of (*insert name*). Nor shall any person fasten a horse to any tree, plant or shrub, or to any device intended to protect the same, or place a post for the hitching of horses within five feet of any tree, plant or shrub in any of the streets or public places of the city of (*insert name*).

6. No building material or any other material of any description shall be piled up against any street tree unless said tree is first sufficiently protected by a proper guard to prevent possible injury, and all instructions issued for that purpose by the board of (*insert name*) must be promptly complied with by the owner.

7. The board of (*insert name*) shall have power to remove any wire conduit or other thing that burns, cuts or chafes any part of any tree, whether trunk, root or branch, in any street or public place, in case the owner of the wire shall fail after three days written notice to take adequate steps to prevent further injury.

8. No paving of any description shall be laid or maintained by anyone between the sidewalk and the curb which shall cut off the air and water from any tree.

Other sections of the ordinances defining the size and kind of trees for planting and the method of setting out may be included and worded so as to conform to local conditions.

WORK OF STATE FORESTER IN PLANTING.

The State Forester has established nurseries on several of the twelve sub-experiment stations, which are located in different sections of the State, where a wide variety of tree species native to the United States and abroad are being grown for experimental and demonstration purposes. This stock will be planted out where it may be observed and the species adaptable for planting in this State determined. Surplus stock will be distributed for further testing and observation. State nurseries may later be the medium for the distribution of stock on a far wider scale than is at present contemplated. There is much to be learned as to the species most suitable for planting in Texas and publications on this subject will be issued from time to time. This Department will, as far as possible, furnish information and advise to cities, towns, schools and interested individuals on the planting and care of trees.

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GENERAL SURVEY OF TEXAS WOODLANDS
INCLUDING A STUDY OF
THE COMMERCIAL POSSIBILITIES OF MESQUITE

BY

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AND

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GENERAL SURVEY OF TEXAS WOODLANDS.

INCLUDING

A STUDY OF THE COMMERCIAL POSSIBILITIES OF MESQUITE.

INTRODUCTION.

The purpose of this report is to acquaint the public with the forest and woodland conditions as they exist in a general way over the entire State. Geography, soil, and climate are discussed, since the natural distribution of the forest depends, in a large measure, upon these factors in a State like Texas which crosses so many varied geologic and climatic zones.

Sufficient time has not elapsed since the establishment of the State Forester's office to have permitted even a hasty examination of the forested areas in all of the wooded counties of the State. Detailed examinations by counties are being made in eastern and other parts of Texas as rapidly as possible, and will be continued until a definite knowledge of the extent and condition of the forests and woodlands and the resources in forest products are known and published for all the State.

Many sources of information have been consulted in preparing parts of the text. Although there is an almost unlimited field for research along geographical and biological lines, including forestry, some splendid works have been published in the past. Of particular value to the writers in preparing this report have been the bulletins of Professor William L. Bray, formerly of the University of Texas, along botanical and forestry lines, particularly the "Distribution and Adaptation of the Vegetation of Texas," published in 1906 by the University, the "Forest Resources of Texas," and the "Timber of the Edwards Plateau of Texas," published in 1904 as bulletins 47 and 49, respectively, of the U. S. Bureau of Forestry. For information concerning the geographic features of the State, the publications of the U. S. Geological Survey relating to Texas have been consulted, particularly the "Physical Geography of the Texas Region," by Robert T. Hill, published by the U. S. Geological Survey in 1900. The Survey kindly donated the four map plates, which show the precipitation, geology,* elevations, and floral features.

Much assistance has been given by persons throughout the State. The State Forester wishes to acknowledge with particular appreciation the

*Since the preparation of this report, the Bureau of Economic Geology and Technology of the University of Texas has issued Bulletin 44, entitled "Review of the Geology of Texas."

information given and help rendered by county officials and the agricultural demonstration agents in all of the counties where this important position has been created.

The practice of forestry is not only related to the great business of agriculture, but the handling of farm woodlots at least, is an important part of it. This is especially true in Texas, where the clearing of new lands in some sections and the reforestation of lands already cleared in others are coming to be questions for the consideration of every farmer and land owner. Each farm should have its timbered portion. The great forest belts of East Texas will eventually become woodlot sections, where the best soils will be in cultivation and the poorer ones devoted to the growing of forests. Farmers and ranchmen throughout Central and in Western Texas should protect their naturally wooded areas and plant new forests on land not needed or of little value for cultivation, thus bringing added returns in wood products for home and local use and protection, comfort, and pleasure to farm dwellers. The future ownership as well as the future welfare of Texas forests must rest largely with those who occupy the land.

PHYSICAL GEOGRAPHY OF TEXAS.

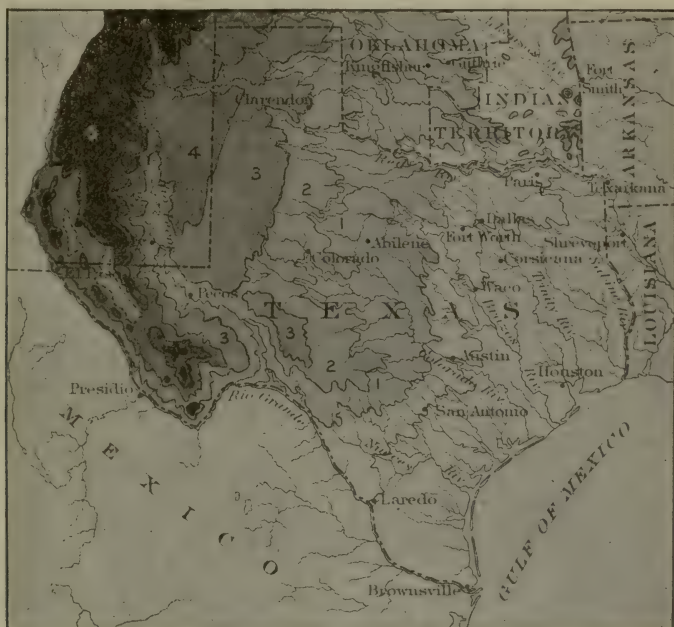
Persons unfamiliar with distances in Texas scarcely realize that about one-twelfth of the area of the United States, or 265,780 square miles, is included within the boundaries of the State. The magnitude of this area is better understood when one realizes that it is equal to the combined area of all the northeastern States, including New England and the States west and south from there as far as Indiana, Tennessee, and Virginia. Its extent is about equal to that of France. The railroad distance across Texas from east to west is about 900 miles, or about the same as from New York to Chicago or Atlanta. Its width is more than one-half the southern border of the United States between the Atlantic and Pacific. The north and south distance is nearly as great.

In respect to location and natural conditions, Texas is the most southern of all the States except Florida; it is one of the great tier of States which forms the central part of the Union. It is a Gulf State and has one-fourth the shore line of the Gulf of Mexico. It is a western State, its extreme western border being nearer the Pacific than the Atlantic. In interests as well as in geographical location and natural conditions, parts of Texas typify the southern, central, and western United States.

Within the State the natural conditions are of the most diverse character. The climate varies from the even warmth of the coast lowlands to the rigors and extremes of the mountainous and elevated interior, and from the heavy rainfall and moisture laden air of the east to the arid conditions of the far west with its hot, burning winds. In relief, the State rises from sea level by diversified terraces to high plains, 4000 to 5000 feet above the Gulf, and then to rugged mountains of the

continental axis. (See Map 1.) Guadalupe Peak, the highest elevation in the State, is 9500 feet above sea level.

It is not easy to distinguish natural subdivisions within the State. Such terms as East Texas, Central Texas, South Texas, and West Texas, indicate popular subdivisions, but the bounds which these terms are intended to designate are not clearly defined and are not well formulated in the public mind. The term "country" is commonly used to designate limited districts, or regions, within the State. Thus we have the Coast Country, Llano Country and many others which more or less definitely define local limits. No set of directional terms can possibly



Map 1—Elevations of Texas.

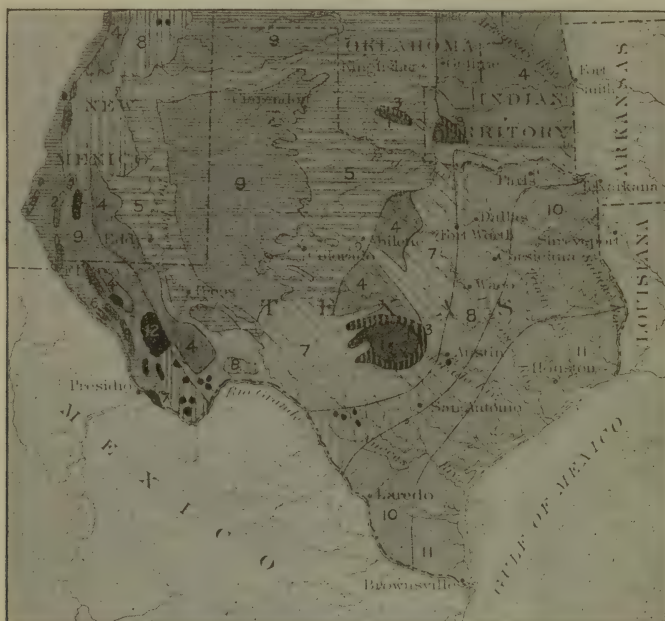
1—1,000 to 2,000 feet; 2—2,000 to 3,000 feet; 3—3,000 to 4,000 feet;
4—4,000 to 5,000 feet; 5—5,000 to 6,000 feet; 6—Over 6,000 feet.

coincide with the natural subdivisions of the State. Therefore, the reader, in considering the geographic and climatic, as well as the forest, divisions is referred to the maps which are included in order to clarify the text and avoid unnecessary descriptions.

In a broad sense the physical characteristics of the State are those of a great, diversified plain, or series of plains, bordered on the southwest by mountains and inclining gently toward the sea. The slope of the plain is rudely comparable to a wide, low stairway leading from the sea northwestward, in which the various subdivisions of the plain represent the treads and the local escarpments, which separate the subdivisions, represent the rises. Great irregularities tend to destroy the

analogy, and the wear and tear of time have scarred and disfigured the relief. In general, the physical characteristics, or relief, are intimately related to the geological formations. The composition and arrangement of the various underlying rock sheets are responsible, not only for the relief, but in a large measure also for variations and peculiarities in soil and drainage, the vegetation and forests, and the agricultural and industrial development of the State. (See Map 2.)

Geographically, Texas may be divided into four large units or provinces: the Central Basin or Denuded Area, the Trans-Pecos Province, the Plateau Province, and the Coastal Plain. These are vast sub-



Map 2—Geological Map of Texas.

- 1-3—Older formations (chiefly granites in Central Mineral region); 4—Carboniferous; 5—Permian red beds; 6—Jurassic (local in Trans-Pecos); 7—Lower Cretaceous; 8—Upper Cretaceous; 9—Staked Plains or Llano Estacado; 10—Lignitic belt; 11—Later coastal deposits (Fayette Prairie and Coast Prairie); 12—Later Igneous outcrops.

divisions and each is capable of division into several, important, smaller units.

The great Central Basin includes the Central Mineral region, of older rock formations, the Carboniferous region, which lies to the north of it along the eastern border, and the Permian Red Beds, which form the western half of the Central Basin.

The Trans-Pecos Province includes that portion of Texas west of the Pecos River. It is a complex region, there being involved in its structure rock strata belonging to almost every geological period. It may be divided into several sub-provinces, two of which are the Stockton

Plateau and the Cordilleran Mountains. The former occupies the southeastern portion and is separated from the Edwards Plateau only by the canyon of the Pecos River. The Cordilleran Mountains are an extension into Texas of the Rocky Mountain system.

The Plateau Province lies between the Central Basin and the Cordilleran Mountains. Two divisions may be recognized, the Staked Plains or Llano Estacado, and the Edwards Plateau. The Staked Plains occupy the northern portion of the Plateau Province and are level, treeless, grass covered plains. That portion lying north of the Canadian River is commonly known as the Panhandle. The southern part of the Plateau Province is represented by the Edwards Plateau, a region which, with the Stockton Plateau, owes its existence to a fault or crack and a bodily uplift from the surrounding country.

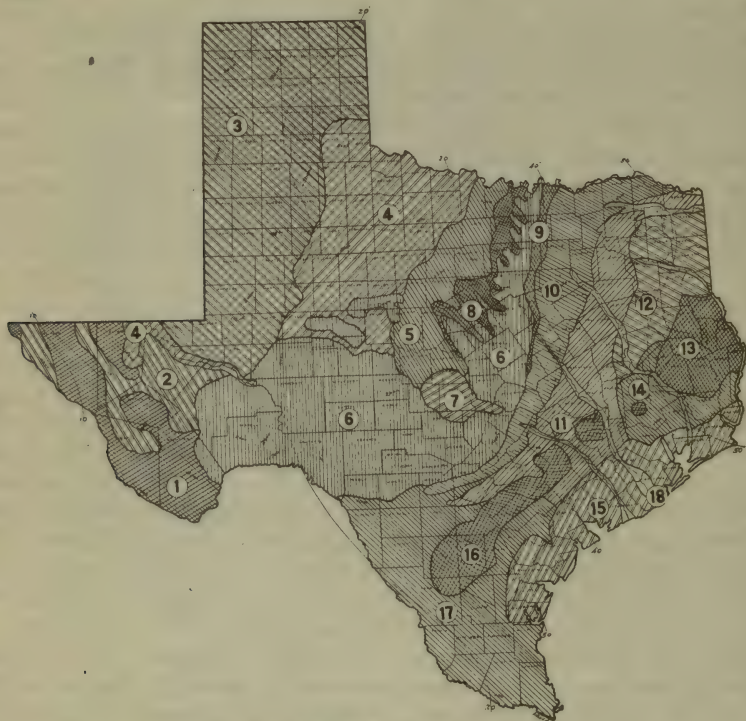
The fourth of these arbitrary provinces is the Coastal Plain, or seaward sloping area bordering the Gulf, which consists of overlapping rock sheets deposited on the sea bottom in consecutive periods from Cretaceous to Recent times. The Cretaceous formation consists of an older or lower and a newer or upper series. The lower Cretaceous series covers a vast area in Texas, including the Grand Prairie region and the Edwards and Stockton Plateaus. The upper Cretaceous formation comprises the well known Black Prairie belt. The Black and Grand Prairies are typical grass prairie country, possessing timber originally only on the bottoms and breaks of streamways and escarpment bluffs. The presence of these features, however, together with the intrusions of two tongues of sand bed country, known as the Cross Timbers, bring a considerable amount of timber within this typically prairie region. The intrusions of Cross Timbers may be considered geologically to be long, narrow strips of sandy deposit extending north and south, the western separating the lower Cretaceous from the Carboniferous area of the Central Basin, and the eastern strip forming a line of division between the upper and lower Cretaceous series. The latter is noticeable between Dallas and Fort Worth, while both become indistinct and disappear toward the south.

Formations, consisting chiefly of the Eocene or Lignitic belt and the Fayette Prairie, are found to the coastward of the upper Cretaceous series, and include in their southwestern extension the region known as the Rio Grande Plain. Covering a region of heavy rainfall in the eastern part of the State, these formations come within the continuation of the Atlantic Forest Belt and are covered with a natural timber growth of pine and hardwoods in East Texas, post oak, live oak, and other hardwoods through the central portion, and characteristic chaparral growth in the Rio Grande Plain section. From the Fayette Prairie to the Coast, a narrow belt scarcely exceeding fifty miles in width, is known as the Coast Prairie. Poorly drained and compact clays and silts alternate with areas having a larger proportion of sand, which are more porous and easily captured by forest growth. This one finds there alternating areas of forest and open prairie.

THE SOILS OF TEXAS.

By A. H. Leidigh.*

The term soil, as here used, refers to the surface material of any given district, except where this material is entirely made up of rock. The soil is the product of disintegrated or worn-out rock material, but in many cases the soil and the rock from which it came are now widely separated; likewise, soils frequently are made up of mixtures of other soils and rock material. Because of these reasons there is not always a very exact relation between the geological formations of a region and its soil.



Map 3—Soil Map of Texas.

Prepared by A. H. Leidigh, Soils Agronomist, Texas Agricultural Experiment Station, College Station, Texas.

Soils vary, not only due to the material from which they are derived, but also because of the amount of clay, sand, plant and animal remains, etc., which they contain. Soils also differ greatly in their openness, stickiness, and like qualities. Many plants grow best on soils of a certain structure, while other plants seem to be adapted to a soil because it contains certain chemicals, rather than because of its structure. All these things have a wide bearing on the conservation of our soil fer-

*Soils Agronomist, Texas Agricultural Experiment Station, College Station, Texas.

tility and on the improvement and future usefulness of the entire land area of our nation. As we learn more about the real nature of our soils we will know definitely how they will "wear," how to maintain their fertility, whether certain soils would really in the end be of more value if devoted to other forms of use than crop production, and by which means they would ultimately return a greater profit.

The soils of the United States are now divided into thirteen great groups or soil provinces, of which five are recognized as occurring in Texas. Nearly one-half of Texas has now been worked over in the process of soil mapping and the soils of most of the State may now be located and classified with some accuracy. The accompanying soil map (see Map 3) is presented to show in a general way the most important soil divisions of the State. Each of the five groups contains a large number of different soils which may be classified roughly into eighteen main divisions. These are briefly grouped and described as follows, the numbers being used to indicate their positions on the accompanying map:

Rocky Mountain Region Soils:

1. Mountainous.

Southwestern Soils:

2. Recent wash and inter-mountain deposits; sometimes containing alkali, gypsum, or salt.

Western Residual Soils:

3. Plains soil; somewhat sandy to the south and the northeast and with clay or clay loam in the north central parts.
4. Permian Red Beds soils; derived from sandstone and shales; sometimes containing gypsum; also some are alluvium.
5. Soils derived from sandstone and shales and associated with coal formations.
6. Residual limestone soil, frequently rocky and badly eroded.
7. Soils of the granitic belt, frequently eroded and thin.

Gulf Coast Plains Soils:

8. Western cross timbers sands.
9. Eastern cross timbers sands.
10. The Blacklands.
11. Sands and plastic clays; sometimes thin; subsoils plastic.
12. Deeper sands and clays; subsoils usually plastic.
13. East Texas deep sands; subsoil frequently friable.
14. Southern extension of the sandy soils; subsoil sometimes friable; depth of sands variable.
15. Soils of the Gulf coast prairie; drainage poor; soil largely clay or underlain by dense clay.
16. Secondary black lands, frequently thin or gravelly.
17. Soils of the Rio Grande plain; sometimes light and of recent origin.

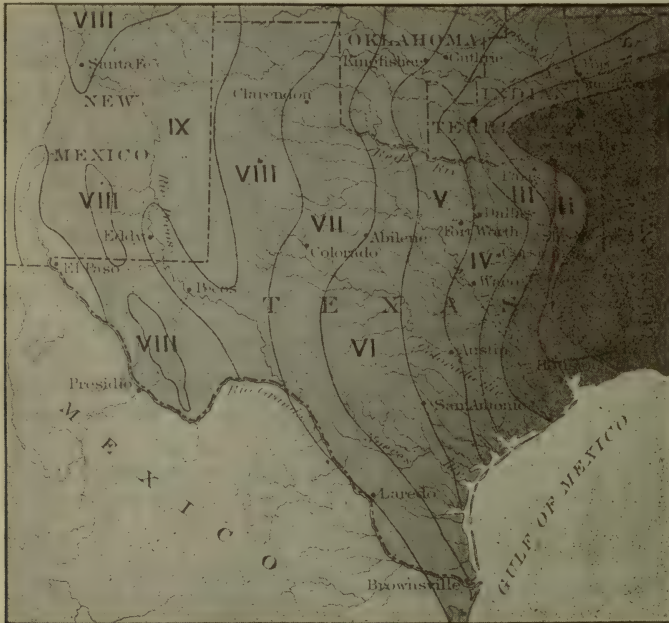
River Bottom Soils:

18. Alluvial valleys.

CLIMATIC FEATURES.

Rainfall.

An examination of the precipitation map (see Map 4) shows that the annual rainfall diminishes in regular proportion from east to west. West of the Pecos River the elevated mountain masses tend to raise the mean annual precipitation over restricted areas, but at the westernmost boundary this average scarcely exceeds 10 inches per year. In the extreme eastern portion of the State the annual rainfall is shown to exceed 50 inches. Between these extremes of wet and dry conditions there is a gradual and uniform transition. The precipitation of the State is mostly rainfall, although one or more extensive snow storms



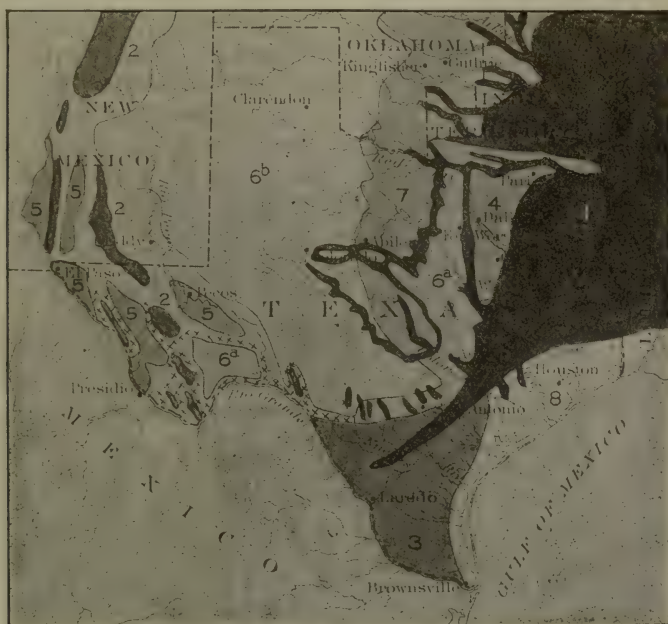
Map 4—Precipitation of Texas.

I—Over 50 inches; II—Over 45 inches; III—Over 40 inches; IV—Over 35 inches; V—Over 30 inches; VI—Over 25 inches; VII—Over 20 inches; VIII—Over 15 inches; IX—Over 10 inches.

occur annually in the Panhandle region. Snow is rarely known south of Austin. More important than the total amount of rainfall is its distribution during the year, which is exceptionally favorable in Texas. According to the records of the U. S. Weather Bureau, the rainfall curve for the State as a whole has its lowest value in January and February; thence increases to May, after which there is a general decrease to the close of the year. Grouped by seasons the three winter months, December, January and February, are driest in all portions of the State except along the southeastern Gulf Coast, where the spring months are driest and over a broad area extending from Burleson and

Waller Counties northeastward to Harrison and Red River Counties, where the summer or fall months are driest. The wettest season is spring in the central and eastern portions of the State, and summer in West Texas and Northwest Texas, the Rio Grande Valley and Coast section, except over a limited area from the lower Rio Grande Valley northeastward to Calhoun County, where fall is the wettest season. The per cent of moisture received during the growing season is least in East Texas and greatest in Northwest Texas, where it is most needed.

In the humid region of the State the annual precipitation is always sufficient to saturate the soil and sub-soil and furnish a constant supply of run-off to the streams. Surface evaporation is retarded by the mantle



Map 5—Floral Features of Texas.

- 1—Atlantic forest belt; 2—Rocky Mountain forest; 3—Chaparral; 4—Black
Prairie; 5—Bolson desert flora; 6a—Grand Prairie; 6b—Great Plains;
7—Transitional, with plains, prairie, and Atlantic flora;
8—Coast prairies; x x x x Yucca belts.

of vegetation and the greater average humidity; also high winds are far less constant. In the more arid portions the conditions are reversed. The rainfall is always local and is seldom sufficient to saturate the sub-soil or to maintain a system of waterways, hence there are extensive areas without visible surface drainage or the streamways are dry during most of the year. Evaporation is facilitated by high winds, absence of humid conditions in the atmosphere and lack of a protecting cover of vegetation.

The forest types in a general way correspond with the zones of rainfall. (See Map 5.) In the eastern region where the rainfall exceeds

45 inches are found the swamp and bayou forests of cypress and tupelo, and on better drained bottomlands the forests of white oak, gum, walnut, magnolia, holly and other moisture-loving species. On somewhat higher lands within the humid zones are found the pines. Passing westward to a slightly decreasing zone of rainfall one encounters the upland type of post oak and in Central Texas, where the rainfall is reduced to 25 or 30 inches, the Atlantic flora disappears except along the streamways and such species as mountain cedar, cedar elm and mountain oaks come into prominence. Approaching arid sections shrub-like forests with numerous leguminous and drouth resisting forms of vegetation predominate.

Temperature.

In a State having such wide variations in latitude and elevation, temperature records must likewise show wide differences in various portions of the State. In average yearly temperature the valley of the lower Rio Grande is considered to differ as much from the northwestern portion of the Panhandle as does New Orleans from Chicago. The difference in latitude between Northwest or even any part of North Texas and the Gulf Coast controls in a large measure not only the crops which may be grown, but the general types of trees and other vegetation found under natural conditions. On the whole, the trees which compose the forests of Texas are those of the southern part of the United States. Species are common along the Gulf Coast and in the Rio Grande Country which are not frost hardy farther north. Many species common to the Middle States, however, are often found and may be grown to the southern limits of Texas. In the high mountains of West Texas are species characteristic of the Rocky Mountains. Temperature is an important agency governing tree distribution.

For the information of the prospective tree planter and the general reader the following temperature records of various Texas Weather Bureau Stations for periods of years are given below:

LOWEST TEMPERATURES.

Station.	County.	No. Years record.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Annual.
Abilene.....	Taylor.....	24	-5	-6	17	25	33	48	55	55	40	30	13	1	-6
Amarillo.....	Potter.....	18	-4	-16	2	6	14	42	51	52	36	23	4	-1	-16
Austin.....	Travis.....	21	15	-1	22	35	41	52	62	60	44	34	25	15	-1
Brownsville.....	Cameron.....	18	18	12	28	37	41	59	57	63	51	38	28	15	12
Corpus Christi.....	Nueces.....	23	16	11	28	44	44	59	65	65	53	42	30	20	11
El Paso.....	El Paso.....	29	5	5	21	29	40	49	56	52	42	28	12	-5	-5
Fort Stockton.....	Pecos.....	12	2	6	15	23	38	46	50	51	40	29	12	8	13
Fort Worth.....	Tarrant.....	11	8	-8	23	31	34	48	56	56	40	31	20	0	-8
Galveston.....	Galveston.....	39	11	8	30	43	52	57	67	68	56	44	29	18	8
Longview.....	Gregg.....	22	7	-7	19	34	39	50	57	48	40	32	21	13	-7
Nacogdoches.....	Nacogdoches.....	11	10	8	23	34	39	48	57	56	37	32	17	19	8
Palestine.....	Anderson.....	28	0	-6	20	36	39	48	60	54	43	34	20	8	-6
Paris.....	Lamar.....	18	7	-13	18	29	38	46	58	56	40	33	17	6	-13
San Antonio.....	Bexar.....	25	6	4	21	35	44	54	60	57	46	37	22	15	4

HIGHEST TEMPERATURES.

Station.	County.	No. Years record.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Abilene.....	Taylor.....	24	83	94	95	99	105	110	110	104	104	94	88	83	110
Amarillo.....	Potter.....	18	74	77	96	90	98	105	99	98	97	89	82	75	105
Austin.....	Travis.....	21	82	87	95	95	96	103	104	103	102	96	85	83	104
Brownsville.....	Cameron.....	18	88	92	98	100	99	102	102	101	102	90	98	93	102
Corpus Christi.....	Nueces.....	23	84	88	96	95	96	97	98	98	99	91	91	86	99
El Paso.....	El Paso.....	29	77	86	93	98	105	113	112	110	104	94	85	77	113
Fort Stockton.....	Pecos.....	12	85	86	92	101	106	114	107	106	103	90	90	81	114
Fort Worth.....	Tarrant.....	11	85	96	97	97	95	103	105	112	102	98	85	83	112
Galveston.....	Galveston.....	30	75	76	85	85	91	97	98	98	94	91	85	77	98
Longview.....	Gregg.....	22	80	83	89	93	100	105	108	110	105	96	93	83	110
Nacogdoches.....	Nacogdoches.....	11	89	98	90	94	97	103	103	109	103	96	86	81	109
Palestine.....	Anderson.....	28	81	83	88	92	93	100	103	108	104	97	87	81	108
Paris.....	Lamar.....	18	83	87	93	90	96	104	108	114	106	98	94	85	114
San Antonio.....	Bexar.....	25	83	90	97	99	98	105	106	107	102	97	90	86	107

FROST DATA.

Station.	County.	No. Years record.	Average date of first killing frost in fall.	Average date of last killing frost in spring.	Earliest date of killing frost in fall.	Latest date of killing frost in spring.
Abilene.....	Taylor.....	23	November...15	March.....15	October....24	April.....23
Amarillo.....	Potter.....	18	November...1	April.....16	October....26	May.....23
Austin.....	Travis.....	15	November...18	March.....12	October....12	April.....12
Brownsville.....	Cameron.....	16	December...18	February...15	November...15	March.....5
Corpus Christi.....	Nueces.....	21	December...26	February...20	November...30	March.....19
El Paso.....	El Paso.....	20	November...11	March.....20	October....30	April.....22
Fort Worth.....	Tarrant.....	17	November...24	March.....8	October....22	May.....1
Galveston.....	Galveston.....	37	December...26	February...3	December...4	March.....1
Longview.....	Gregg.....	19	November...16	March.....12	October....26	March.....31
Nacogdoches.....	Nacogdoches.....	11	November...12	March.....10	October....21	April.....18
Palestine.....	Anderson.....	28	November...13	March.....13	October....20	March.....30
Paris.....	Lamar.....	18	November...15	March.....20	November...3	April.....12
San Antonio.....	Bexar.....	23	November...28	February...24	November...9	March.....20

SUMMARY OF CHARACTER AND CAUSES OF DISTRIBUTION OF TREE GROWTH.*

Texas presents a great diversity of flora.† Some areas are densely forested; others are vast treeless plains; others are stretches with scattered trees; while still others are covered with low shrubs. The forests follow in a general way the structural features in definite belts of country but are modified, not to say controlled, by climatic variations. The principal natural influences which have really determined the character and extent of tree distribution are rainfall, nature of the soil and rock, temperature, sunlight and winds. The first two are by far the most important. It is often stated that where the annual rainfall is less than 12 inches arid conditions are produced; that 12 to 18 inches render the land suitable for grazing only; more than 18 inches are favorable for agriculture, while more than 100 inches produce vegetation too

*A bulletin entitled "Deforestation and Reforestation as Affecting Climate, Rain, and Production." by Moya Wicks, of the San Antonio Scientific Society, has been published by the State Department of Agriculture, Austin, Texas.

†See Bulletin 22, published by the University of Texas, Austin, Texas, entitled "The Trees of Texas," by Dr. I. M. Lewis.

luxuriant for agriculture. This is only in the main true. Many species of trees when once well established grow luxuriantly over portions of the Great Plains and the Central Basin, where the rainfall does not exceed 20 or 25 inches a year. When suitably cultivated, trees are grown without irrigation in the extreme northwestern Panhandle, where the rainfall is less than 15 inches. Rainfall alone does not determine the limits within which forest types are found but is undoubtedly the most important controlling factor, as is shown by the gradual transition from moisture-loving to drouth-enduring species which takes place along the line of decreasing rainfall.

The nature of the soil and rock have an important influence in the distribution of tree growth. Heavy timber in the canyons of the Edwards Plateau, on the broken strata of mountain masses and along breaks in regions of low rainfall is accounted for by the supply of percolating waters made available through the character of the rock structure. On the other hand, the waxy clay soils of the Black Prairie, which tenaciously retain moisture supplied by an abundant rainfall, are not generally forested. Natural treeless prairies are characteristic of the southeast Texas Gulf section and large portions of the Fayette Prairie and Lignitic belt, which cannot be accounted for by lack of rainfall. They are explained in part at least by the impervious, compact condition of the soil which does not furnish sufficient air to satisfactorily supply the roots of many kinds of trees unless it has been broken up and made mellow and porous by cultivation. Competition with native grasses also helps to exclude tree growth on these areas. Lack of aeration of compact soils has a larger influence in determining tree distribution and types of forest in many parts of the Coastal Plain than any other factor, rainfall not excepted.

Temperature is a dominant selective agency so far as the adaptation of species to regions varying widely in length of growing season, dates of early and late frosts and in duration and severity of periods of cold weather are concerned. It distinguishes the flora of the Coast country from that of North Texas and characterizes the flora of the State as a whole.

Texas presents extremes in the amount and intensity of sunshine which are reflected in the character of the forest growth. The moist atmosphere and the high percentage of partly or wholly cloudy days in the eastern region prevent the intense illumination found in the regions farther west and the forests develop as a consequence thick crowns and a heavy undergrowth of shade-loving species. Except in moist canyons the western forests are conspicuously wanting in shade-loving and dense foliated species.

In the Coast Plain country and on the Great Plains the wind tends to hinder the spread of timbered areas and on exposed situations results in trees of low form. The periodical occurrence of Gulf hurricanes has a profound effect on the history of forest extension and the present aspect of the Coast Plain forests. The ragged, uneven growth of timber in the Coast country is the most evident effect of these storms. On the

Great Plains the habitual direction and force of the wind must be taken into consideration in the methods of planting and the choice of species.

THE EAST TEXAS TIMBER BELT.

The East Texas Timber Belt is the western extension of the great yellow pine and hardwood forests of the Atlantic and Gulf Coastal Plain, reaching from Virginia through the Carolinas to Florida and westward through Alabama, Mississippi, and Louisiana to the eastern counties of Texas.* Further extension of this vast forest belt is checked by decreasing rainfall and other conditions unfavorable to the majority of species composing it. The forest becomes broken into straggling detachments within which only the hardier species push onward along the prairie streamways. Dr. Bray has described this phenomenon as follows: "Like a vast wave that has rolled in upon a level beach, the Atlantic forest breaks upon the dry plains—halting, creeping forward, thinning out, and finally disappearing, except where, along a river course, it pushes far inland."

The East Texas Timber Belt is composed of natural regions, or subdivisions, of which the most important are loblolly pine, longleaf pine, shortleaf pine, bottomland forests, swamp and bayou forests, and the post oak woodlands. (See Map 6.)

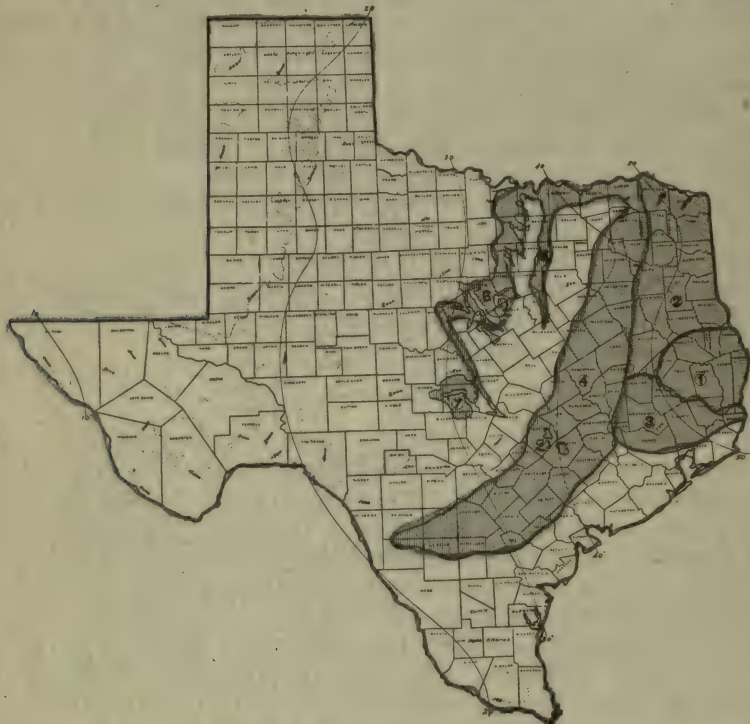
Loblolly Pine Region.

The loblolly pine region probably occupies 6000 to 7000 square miles in the southeastern portion of the East Texas Timber Belt, between the longleaf pine region and the treeless, grass-covered portion of the coast prairie which extends inland from twenty to fifty miles or more from the Gulf. East and west the loblolly pine extends from the Sabine River nearly to the Brazos, occupying the interior portion of the coastal prairie and changing on the north to longleaf and shortleaf pine, as the coastal prairie passes into the drier, more porous soils of the Fayette Prairie formation. The loblolly pine region embraces the northern portions of Orange, Jefferson, and Harris Counties, the greater part of Liberty and Hardin Counties, and all of Montgomery, San Jacinto, and Walker Counties. Portions of Grimes, Waller, Newton, Jasper, and Chambers Counties are properly within the region. Scattered trees or groups of loblolly pines are found as far south and west as Brazoria County and larger bodies of this species are located in Colorado, Fayette, and Bastrop Counties, where they are growing under quite different conditions.

The southern portion of the loblolly pine region consists of alternating belts of open prairie and timber land. Near the Gulf the timber is entirely lacking and only an expanse of poorly drained sea marsh and grass prairie exists. Farther inland patches of timber begin to

*See Bulletin 13, Forestry Division, U. S. Department of Agriculture, Washington, D. C., entitled "Timber Pines of the Southern United States."

appear along the streams or on natural elevations of sandy, porous soil. These patches become larger farther north, gradually forming extensive bodies of timber, until finally the prairie gives way to a continuous forest of loblolly pine and hardwoods, except where land has been cleared for rice and other crops. Along the southern border the forest tends to succeed the prairie in the process of reclaiming marsh land areas and, except along the larger streams, this forest is of comparatively recent development. The islands of timber show older growth in the center and younger growth around the edges. Prairie fires are the chief ob-



Map 6—East Texas Timber Belt.

- 1—Longleaf pine region. 2—Shortleaf pine region. 3—Loblolly pine region.
4—Main body of post oaks. 5—Eastern cross-timbers. 6—Western cross-timbers. 7—Central Mineral region.

stacle to the more rapid enlargement and extension of these forest islands which usually have their beginning in pure stands of loblolly pine. As the stands become more open, hardwood species creep in to form mixed types, such as are found along the rivers and lands adjacent to them, known as "river swamps," and in depressions on the higher uplands, known as "bay galls." Pure stands of loblolly pine on old fields are less common in Texas than in loblolly pine regions of other Southern States, where large areas were in cultivation many years ago and have since been abandoned.

Loblolly pine is primarily a tree of the lowlands which border the swamps and streams. Where the soil is poor and sandy but quite moist

it occurs in more nearly pure stands, where the soil is fresh and fertile the ground is shared with many hardwoods. Along the low ridges, on sandy knolls, and in abandoned fields made more retentive of moisture by cultivation, loblolly pine is likely to occur in pure stands. In the stream bottoms and on flat, semi-swampy soils the oaks are abundant, and gum, holly, beech, hornbeam, maple, magnolia, and other hardwoods are mixed with loblolly. In these situations the abundance of palmetto and vines together with the pine and hardwoods often form thickets, the largest of which is the so-called "Big Thicket" of Hardin County. Usually pine does not form more than 25 per cent of the stand on these poorly drained areas, but it is of larger size and better quality than occurs in the pure stands.

Together with white and overcup oak loblolly pine* is cut for railroad ties far more extensively than for any other purpose. Nearly 700,000 ties represent the present annual output from the counties in the loblolly pine region. Other products from loblolly pine are lumber, packing boxes, charcoal, piling, ship timber, and telephone poles. Hickory for handles and staves from various species are products from associated hardwood trees. Present methods of tie cutting are extremely wasteful and logging leaves little chance for the permanent continuance of these important industries. Scrub oak is apt to follow loblolly on cut-over lands and with recurring fires loblolly is hindered in its reproduction and can return but slowly.

Longleaf Pine Region.

The longleaf pine region occupies some 5000 square miles of the East Texas Timber Belt. The region lies north of the loblolly pine region and extends from the Sabine River as far to the southwest as the Trinity River, where the loblolly and shortleaf pine regions meet to form its western boundary. On the north longleaf pine gives way to shortleaf pine approximately along a line through the northern boundary of Sabine, San Augustine, central Nacogdoches, northwestern Angelina, and the central part of Trinity Counties. In addition to the above, Polk, Tyler, Jasper, Newton, and the northeastern portion of Hardin Counties are within the longleaf region. This is not a large region but it includes the finest bodies of timber in Texas and is the center of the lumber and turpentine industries of the State. It nearly coincides with the Fayette Prairie formation east of the Trinity River. The altitude is above that of the loblolly region, ranging from 100 to 300 feet, and the country is rougher and better drained, except along the southern margin where it is flat and really overlaps the coastal belt. Sandy ridges and deep, open textured soils are characteristic of the longleaf country. Longleaf pine is able to thrust its tap root deep into the soil and in a measure is independent of dry sur-

*For further information on this subject, see Bulletin 64, Forest Service, U. S. Department of Agriculture, Washington, D. C., entitled "Loblolly Pine in Eastern Texas."

face conditions. Depressions between sand ridges and other less well drained areas support a good part of the hardwoods and loblolly pine found in the region.

The forests of longleaf pine originally formed nearly pure stands of remarkable quality and uniformity, covering extensive areas, and interrupted only by stream bottoms and moist depressions. On dry, sandy soils this species finds a refuge from the competition of other trees which it cannot endure on moister, better sites. With the long, clear stems of the longleaf pine and the open park-like and grass-covered condition of the forest floor, these forests in their natural condition were in a class by themselves among the timber regions of the world.



Virgin Forest of Longleaf Pine in Eastern Texas—Jasper County.

Agriculture developed and prospered and grazing was an important industry long before the forests were marked for destruction by lumbering operations. The greater part of these forests has now been cut and only where bodies of timber are held for higher values by land owning companies does one find extensive bodies of longleaf pine not in the process of being lumbered. Earlier methods of logging only removed large, mature trees. Present day methods, with the use of steam skidders, destroy most of the unmerchantable timber formerly preserved. This process leaves nothing for a second cut and often not even enough for seed trees to restock the land again. The frequently recurring fires which effectually destroy all pine seedlings on the ground and the in-

ability of large areas to again become stocked after lumbering, result either in the formation of scrub oak thickets or else the cut-over lands become stump covered grass or waste areas.

Absence of a humus covering of the soil is a characteristic of the longleaf forest, whether in virgin, culled or cut-over condition. This is due to repeated fires over long periods of years which prevent the accumulation of leaf litter, in spite of the fact that longleaf pine creates an excellent humus where fires are kept out. The value of organic matter in the forest soils has never been duly appreciated. Not only because of its water holding capacity and its consequent effect in retarding the rapid run-off of rainfall, thus tending to prevent both overflow



Appearance of a Longleaf Pine Forest after Lumbering—Jasper County.

and periods of drouth, humus has a soil enriching value which is needed when the lands are cleared for agriculture and which would greatly improve the quality and abundance of the grass cover for grazing purposes.

This is primarily a region of gigantic sawmills and lumbering is the principal forest industry. The annual output of lumber exceeds 1,000,000,000 feet and has probably now reached its maximum. Each year finds a number of older plants abandoned but new ones in hitherto unexploited districts are started. The output of lumber from Jasper County is about 300,000,000 feet or double that from Polk and San Augustine Counties, respectively. These three counties lead in lumber production. The larger plants will operate for varying lengths of time,

ten or eleven years being the average time to run and twenty years the greatest length of time recorded.

Longleaf pine is the turpentine tree of the United States. About 281,000 acres of this timber in the longleaf region of Texas are being operated for naval stores products. This area is small as compared with the extensive operations in similar regions of other longleaf pine States.

In addition to lumbering and turpentineing large quantities of ties, staves, telephone and telegraph poles, piling, and fuel wood are produced. The ties are obtained either from farm lots or cut-over timber



Mixed Shortleaf Pine and Hardwood Forest in Northeast Texas.

holdings and culled areas. Except the larger sawmill plants these industries will continue indefinitely.

Shortleaf Pine Region.

The area included within this region covers all the northeastern counties of Texas as far south as the longleaf and loblolly pine regions and as far west as a line drawn from the western part of Red River County through Franklin, Wood, Smith, Henderson, and Anderson Counties to the Trinity River, continuing southward along this river and meeting the loblolly region in Madison County. It is the largest of the yellow pine subdivisions, 30,000 square miles or more in area, and is well developed agriculturally. The shortleaf pine region occupies the north-

eastern portion of the Lignitic geological formation. Elevations range from 300 to 500 feet and the topography is much more hilly than in the longleaf region. The soils are variable clays and sands with extensive areas of red clay formation. A rainfall of 40 inches or more insures luxuriant vegetation and crops. The decrease in rainfall to less than 40 inches westward from this region is the principal reason for the rapid disappearance of pine, since the topographic and soil features differ less abruptly.

Shortleaf pine is the most important species in the upland forests. It occurs in nearly pure stands but is oftener found growing in mixture with post and other upland oaks, hickory, elm, and sweet gum. Post, red, black jack, white, and blue jack oaks are often found as an understory with pine in the uplands. Extensive bottomlands border the rivers and streams. Here hardwoods prevail with such species as white, red, overcup, and Spanish oaks, elm, sycamore, and a wide variety of other species making up the mixture.

Of the great number of tree species found in the region, shortleaf pine has been the only one of wide commercial value.* Shortleaf pine lumbering began in the days of early settlement and much of the virgin growth was disposed of before lumbering became extensive in the longleaf and loblolly forests. In 1880 the output of shortleaf pine was over 146,000,000 feet as compared to 61,000,000 of longleaf. Today the larger sawmills have almost entirely disappeared. Lumbering in the shortleaf forests is still extensive but on a smaller scale by a larger number of mills. The present annual output of shortleaf pine is nearly 500,000,000 feet, much of which is cut from forests logged twenty to forty years ago and from strictly second growth forests. The earlier logging was less severe than that carried on today. Even present day operations do not strip the lands like the operations now carried on in the longleaf region. A greater amount of hardwoods in mixture with pine is, of course, partly the reason for the better conditions found on the cut-over lands of the shortleaf region. Small mills cutting intermittently or in conjunction with cotton gins are likely to continue indefinitely.

The lumber business on a large export scale has already given way to diversified forest industries. Small wood-using plants which manufacture crates, boxes, pails, tool handles and other implements, furniture, veneer products, and many other articles in common use, may be found in the shortleaf pine counties. The culled pine forests and hardwood areas of this region produce annually more than 1,000,000 ties. Mine props are exported from several counties. Fuel wood and fence posts are not only used in vast quantities locally, but are shipped to the western counties and other States. A few counties still export stave stock, but the oak suitable for first class staves has become largely exhausted.

*For further information, see Bulletin 308, U. S. Department of Agriculture, Washington, D. C., entitled "Shortleaf Pine: Its Economic Importance and Forest Management."

The shortleaf pine region has become an important agricultural section. The best lands are being put under cultivation. Fruit growing is increasing. Abandoned farm areas are being reclaimed. Large cut-over forest tracts are being divided into farms. Woodland areas are coming more and more to be looked upon as farm woodlots. An adjustment of land areas to their best use is taking place. With increasing values of land and forest products and the division of large areas into smaller farms, the woodlot is being recognized as a necessary and important part of each farm. The study of market conditions and the better management of farm woodlots are lines of work which the farmers and woodland owners in this region will be ready to undertake in the near future.

*Bottomland Forests.**

The rivers and streams which flow through the Lignitic formation of Eastern Texas have worn broad channels upon which rich alluvial soils have been deposited. These bottomlands intersect the uplands of the shortleaf, longleaf and loblolly regions from the Red River to the lower Sabine and Trinity Rivers, and extend westward along the lower courses of the Brazos, Colorado, San Antonio, Guadalupe, San Bernard, and other streams. Along the larger rivers these bottoms are frequently five miles or more in width. In the aggregate they cover thousands of square miles of area. The soils are deep and fertile and are overflowed only for short periods following heavy rains. Large areas of these bottoms in Eastern Texas are already cleared and under cultivation. Along the streams farther west clearing has been far more extensive and the majority of bottomland areas are more or less devoted to agricultural uses.

These bottomlands were once, and in many East Texas counties they still are, covered with magnificent hardwood forests. Remote from railroad lines and wagon roads stands of timber may be found which are unsurpassed in the size and quality of their trees. Nearly all of the species common to the Atlantic States are found in the bottoms of eastern Texas. West of the Trinity River the bottomland species gradually become fewer and of less luxuriant growth. The bottoms of the Navasota River, a tributary of the Brazos, mark the western limit of a number of species of commercial importance farther east. On the Brazos, Colorado, and Guadalupe Rivers, and the streams west of these within the Cretaceous formation, the trees of the Atlantic type of bottomland forest disappear, except in specially favored situations.

The removal of timber from bottomland forests has been a constant process extending over many years. The more valuable specimens of

*For further information concerning Texas hardwood species see the following publications of the U. S. Department of Agriculture, Washington, D. C.: U. S. Forest Service Bulletin 58, "The Red Gum"; U. S. Forest Service Bulletin 80, "The Commercial Hickories"; U. S. Department of Agriculture Bulletin 24, "Cottonwood in the Mississippi Valley"; U. S. Department of Agriculture Bulletin 299, "The Ashes: Their Characteristics and Management."

white, overcup, burr and cow oaks, white and green ash, black walnut, hickory, cottonwood, and basswood (linn) have been cut out. There is an abundance of young growth of these species and vast quantities of timber of large size among the species hitherto considered of little value, such as red, black, willow, and water oaks, some species of hickory, sweet, black, and tupelo gums, sycamore, elm, magnolia, holly, maple, and others. Stave cutters have sought the white oaks while other valuable species have gone for veneer stock, boxes, headings, furniture, and a multitude of other products. The rapid development of small wood-using industries, particularly in Northeast Texas, has made it profitable to haul these hardwoods long distances from the bottoms to the mills.

Large quantities of timber in the bottomland forests yet remain to be harvested. The value of Texas hardwoods is only now beginning to be recognized. A number of new hardwood mills are being put into operation and the quality of our native hardwoods is being widely and systematically advertised over the country for the first time this present year. Market values are steadily increasing and stumpage prices may already be considered high in restricted localities. Unfortunately this is not true throughout and many farmers in clearing lands continue to deaden timber which, if near a mill, would bring \$10 to \$15 per thousand feet. For lack of a correct knowledge of market values many farmers are practically giving away their hardwood timber. It would be far better to keep their timber standing a few years longer than to sell for perhaps \$1 per thousand feet stumpage for which the owner may receive \$5 or more in the near future.

In the western extension of these bottomland forests the elms, hackberry, pecan, Texas red, burr, and live oaks, sycamore, cottonwood, and other less important species prevail. Pecan culture becomes an important industry. Native pecan trees are not only spared for the nuts but are improved by top pruning and grafting and furnish substantial incomes to their owners. Other species are not valued highly but they furnish an unlimited supply of fuel, posts, and other products.

Swamp and Bayou Forests.

Forests of this type occur chiefly in the undrained Coastal Plain within the loblolly pine region. Along all of the streams of the coast lowlands east of the Trinity River the forests show to a greater or less degree the characteristics of this type. Farther interior, the type prevails wherever the streams are sluggish and are accompanied by swamps and bayous undrained throughout the year. As compared with the extensive bayou forests of Louisiana, these areas are decidedly restricted in Texas. They are most abundant along the lower Neches and Sabine Rivers toward Beaumont and Orange.

Bald cypress and tupelo gum are the principal species composing this type. With these are usually associated water oak, water ash, swamp maple, sweet magnolia, black gum, swamp hickory, and sweet gum. Where the surface of the soil becomes greatly submerged, tupelo and cypress may be unaccompanied by other species. Peculiarities of structure enable these two to endure such an environment.

Bald cypress is an exceedingly valuable commercial timber tree where it occurs in sufficient quantities.* The cypress lumbering operations of southern Louisiana are second only to yellow pine in that State. In Texas, cypress is not plentiful enough to be of special importance. There is some good cypress in Jasper County and one tract containing 5,000,000 feet within a few miles of the county seat of San Augustine County. Scattered specimens are common along every lowland stream and there are minor cypress swamps, but the best of this timber has long ago been cut out. Tupelo gum is much more plentiful and is available, along with alluvial bottom hardwoods, for a variety of future uses.



Swamp and Bayou Forest consisting of Cypress and Gum—Southeastern Texas.

Post Oak Woodlands.

The main body of post oak woodlands, as here described, occupies the region between the western limit of the shortleaf and loblolly pines and the Black Prairie belt of East-Central Texas. Southwestward this post oak country extends in a narrowing belt nearly to the Rio Grande River. It occupies the western and southwestern portions of the Lignitic geological formation, the eastern portion of which lies within the pine regions. Decreasing rainfall and the changing physical condition of

*For further information, see Bulletin 272, U. S. Department of Agriculture, Washington, D. C., entitled "The Southern Cypress."

the soils are primarily responsible for the falling off of pine and the general character of the existing forests. Toward the Rio Grande River tree growth constantly becomes more open and dwarfed and the Atlantic species, one by one, give way to dry-land species extending northward from Mexico. Outside of the main body of post oaks conditions adaptable to this forest type are found in the Eastern and Western Cross Timbers, and extending in irregular bodies from the Red River to and including the granitic area of the Central Mineral region, wherever sandy or gravelly soils occur. The terraces along the Colorado River near Austin are also occupied by the post oak type.

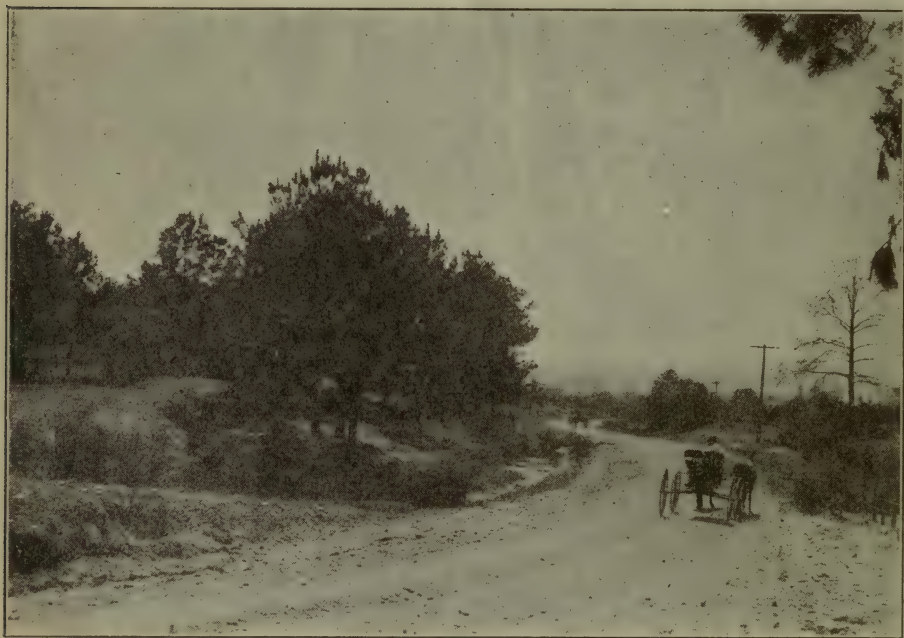
The soils are in general sands and gravelly clays with pockets of



Interior of a Typical Forest of the Post Oak Belt—Brazos County.

impervious clay forming small, open grass prairies. The best of these soils are in cultivation and the heavier clays form pasture areas. Absence of pine and the low, scrubby character of the oak forests, separated by patches of open, grassy prairie, are the striking features of the landscape. It is the type which the Atlantic forest assumes in passing to more arid sections of the Southwest. The eastern portion of the region contains many important hardwood species of fine quality which, unfortunately, lack a suitable market. The result is a great waste of valuable timber in clearing lands. The western limit, on the other hand, marks almost an entire absence of Atlantic species, except on areas where soil water is made available as in the Cross Timbers, the

granite country, and along river terraces. Post and black jack oaks are the principal species composing this type. Even these have short trunks and rounded crowns and the forest presents an open, dwarfed appearance. The post and black jack oaks are of little commercial value and are used chiefly for fuel and fence posts. There is a wealth of tie timber and the larger trunks, 12 to 24 inches in diameter, are excellent for certain kinds of construction timber. Red cedar is widespread and of considerable commercial importance in certain localities. Isolated bodies of loblolly pine are found on the bluffs along the Colorado River in Bastrop, Fayette, and Colorado Counties. Comparatively few forest industries are in operation within the region. Stumpage



Loblolly Pine as it Occurs in the Hills along the Colorado River—Bastrop County.

values are low and owners realize little from their holdings except for domestic and local use. These cheap and apparently inexhaustible woodlands, however, furnish much indirect wealth to the inhabitants. More than 50 per cent of the land is in cultivation or pasture, increasing toward the Black Prairie belt. The abundance of cheap and serviceable wood means a great saving to every farmer who, if located in the Black Prairie or Panhandle, would be forced to purchase the necessary fuel, posts, and other rough products from local yards or haul them from distant points. A lack of this timber would mean a hardship to many upland farmers.

This extensive region, adjacent to or a part of the great agricultural region of Central Texas and near many large towns and cities, is

destined to be an important woodlot region. To this end the woodland connected with every farm should be kept in vigorous growing condition by the saving of young, thrifty, and rapid growing trees. Selective cutting rather than clear cutting, fire prevention, and the restriction of grazing on areas where young timber growth should be encouraged, are the lines along which woodlot management should be extended.

Summary of Conditions in Eastern Texas.

The East Texas Timber Belt no longer represents a great belt of timbered lands, as the name implies. It is rather a combined agricultural, grazing, and forest region, portions of which still contain an abundance of timber and maintain large forest industries. The counties which comprise this region supported an agricultural population before the lumber industry on a large scale invaded the State. Over large portions of the region lumbering has reached its zenith and declined. In other portions it is now at its maximum and overshadows all other interests. In forty eastern counties, with an area of nearly 21,000,000 acres, one-third of the area consists of cut-over forest lands, nearly one-third is improved agricultural land, and the balance is made up of virgin, culled, and second growth forests, waste, and overflowed lands.

Agriculture is well advanced in the northeastern counties, where lumbering on a large scale first began and has since declined, and has been most delayed in those counties where lumbering still dominates. The time is approaching when the remaining large timber tracts will be cut over. There is every reason to hope and expect that large bodies of cut-over lands will be divided into farms and the best of them improved. Most woodland areas of the future will properly become parts of farms and should be protected and handled so as to produce fuel, posts, lumber, and other forest products for home use and for sale. It is impossible to believe that all of the millions of acres of cut-over lands will be needed or can be used for the growing of annual crops. Attached to farms or as well managed forests they are an important part of an agricultural region. Increases in stumpage values are constantly taking place and when the large timber holdings are gone, products from farm woodlots and small timber holdings will have a value comparable with those in agricultural regions of other sections of the country which are high today. The variety of forest products has already greatly increased and stumpage values are relatively high in many of the best agricultural counties of northeastern Texas, where the lumber industry on a large scale has disappeared. Hardwoods hitherto not exploited are coming into the market where once only pine was manufactured. Forest products in a variety of forms are being utilized along with the advance in agriculture and the more intensive use of land. The economically valuable forests of the future will be those of small size in well populated sections where the products can be easily marketed and are in demand.

Certain fundamental necessities in the economic care and use of land

should engage our attention at once.* Grass and woodland fires should no longer be tolerated, sapping the nitrogenous plant food from the soil, destroying the young growth of timber which future generations have a right to possess and use, and causing rapid run-off of surface water with its resultant havoc in gulying and overflows, followed by dry streams and drouth. Buildings and fences are burned, birds are driven from the country, the quality of the forage grasses is reduced, and other ills too numerous to mention can be laid to the negligence and indifference which permit fires to run at will over our lands.

Stock laws should be enacted, particularly a hog law, to keep stock within enclosures and thereby put an end to a condition which is intolerable in a well developed agricultural region. Hogs have no place in woodlands which are properly handled, since they eat the seed and grub out the seedling trees needed to produce new forest growth, particularly on cut-over lands. One of the chief causes of burning is due to stock grazing because of the erroneous belief that the range is improved thereby. There are serious agricultural reasons why a stock law is essential.

The time will come when tree planting will be commonly practiced on waste and denuded areas not needed for agriculture. This is being done today in States where the increased value of land covered with a young growth of timber trees has become recognized.

TIMBERED AREAS OF THE EDWARDS PLATEAU AND THE REGIONS TO THE NORTH.

The region described under this heading consists of the Edwards Plateau, which is the rough, deeply eroded, southern margin of the Great Plains, the Central Basin or Red Beds country, and the Carboniferous Region. (See Map 7.) Small, scattered areas of Edwards Plateau formation occur far to the north of the main region and many of the hills, bluffs, and isolated buttes throughout North-Central Texas and westward to the Breaks of the Plains contain tree species typical of the Edwards country. The southern and eastern borders of the Edwards Plateau are well defined by the abrupt fault line, known as the Balcones Escarpment, rising above the prairies.

Next to the forest belts of Eastern Texas the Edwards Plateau is the most important timbered region of Texas in spite of the fact that climatic conditions tend to favor grass cover rather than forests. Erosion has resulted in steep bluffs, deep gorges, isolated buttes, long, even slopes covered with debris, and everywhere broken rock strata where sufficient moisture is retained to produce a forest cover. This has been encouraged during recent years by the interference of man. The development of agriculture and grazing have operated to prevent the

*See Bulletin 364. U. S. Department of Agriculture, Washington, D. C., entitled "Forest Conservation for States in the Southern Pine Region." Also Bulletin 1. Department of Forestry, College Station, Texas, entitled "Grass and Woodland Fires in Texas."

recurrence of grassland fires which, in the ages gone by, effectually kept out the woody vegetation. Within the memory of men now living in the Edwards Plateau counties this region was primarily grass covered. The reduction of fires, brought about by fencing and the division of large areas into smaller farms and ranches, together with over-pasturing, have been followed by an invasion of woody growth, thickets, and wide areas of timber covering which constitute one of the most interesting and remarkable of land transformations. Open grassland still occupies large areas but most of the land is covered with either a scattered, scrubby growth or with timber of sufficient quality to be classed as timbered land.



Map 7—Edwards Plateau Timber Types.

1—Edwards Plateau proper. 2—Extension of forest types in the Central Basin and Carboniferous regions.

There is not sufficient moisture to permit of dense forests, except in the sheltered and well watered canyons. The appearance of the tree growth in general is that of a semi-arid region. As one goes west and northwest from the deeply eroded eastern face of the Edwards Plateau the quality of the timber growth decreases and the continuity of the forest disappears. Throughout the more extreme limits of the region here described, tree growth of the true Edwards Plateau type is confined to stream borders or to the summits of the hills and ridges.

The Edwards Plateau is a common meeting ground for species from the Atlantic forest belt, the southern Rocky Mountains, and the north Mexican highlands. Ninety species of trees and shrubs have been recognized in this region. Many Atlantic species, surviving conditions found here, have become permanently changed into new species, though showing close kinship. A discussion of the commercial species is best given under the three prevailing conditions of forest found, namely: the timber of the streams and canyons, the hill and bluff timber, and the prairie timber.

Timber of the Streams and Canyons.

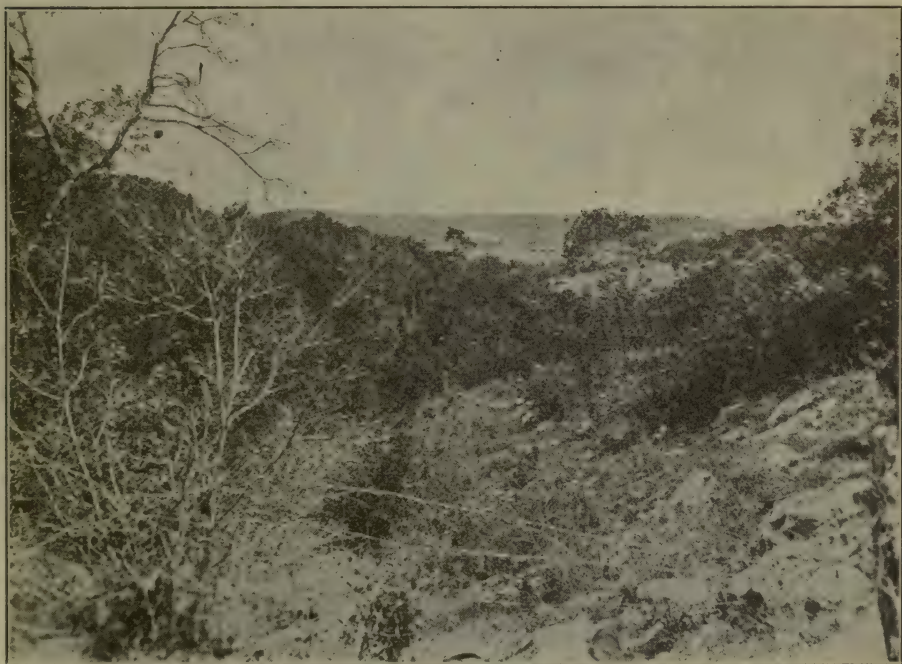
Many of the species found along the streams which flow through the Edwards Plateau or which flow from springs along the eastern escarpment are those of the Atlantic flora, extensions of the eastern bottom-land type. One is amazed to find within these canyon bottoms cypress of the East Texas swamps and bayous growing to several feet in diameter. Cypress at one time was abundant and much of the early construction in San Antonio and other sections near the canyon bottoms was of this species. American elm, sycamore, live oak, pecan, overcup, red, burr, and other oaks, cottonwood, hackberry, and walnut are among the most valuable species found in this type. Other species of interest are black cherry, dogwood, and box elder. Many of the narrow alluvial bottoms which formerly supported these species are now cleared along the principal streams flowing out of the Edwards Plateau. The cultivation of native pecan is a recognized industry and along the streamways of most of this region, particularly in the San Saba country, excellent groves of native trees are found which bring large returns to their owners. Live and burr oaks, four to five feet in diameter, are not uncommon.

Hill and Bluff Timber.

This represents by far the greater part of the timberland of the region. On the limestone hills it occurs in varied forms wherever erosion or dissection has taken place. Along the breaks of the streams, on steep slopes and rough hills, and on isolated limestone remnants of the Edwards Plateau far to the north and northwest of the main body, a mixed forest of mountain cedar, live oak, mesquite, cedar elm, hackberry, mountain oak, shin oak, sumac, and other species prevails. On the more level uplands mixed forests of the same general character are found, but they are interspersed with grassy areas and are more scrubby. Timbercapped buttes are a feature of the Burnet and Lampasas sections. In such places the debris covered lower slopes are too unstable to permit the capture of the soils by timber growth.

Several of the species composing these mixed forests are commonly found growing in nearly pure stands or else under different conditions of growth and density. They thus form well recognized types, such as the shinneries, mountain oak thickets, post oak areas, and the cedar brakes. The shinneries are dense, dwarf thickets of shin oak, with

live oak and other species in mixture, growing on rocky, limestone areas. These thickets cover many square miles north of the Edwards Plateau and are found in smaller patches of shrub-like character as far west as the Breaks of the Plains. Mountain oak thickets, consisting of a species of oak closely related to the Texas red oak, are found on the tops of mesas and buttes, sides of gorges, and frequently on lesser slopes where they form dense, pure stands of fair quality. The trees are symmetrical and of rapid growth. The wood has a high value for fuel and is adapted to other uses.



Forest Growth on the Hills of the Edwards Plateau—Kerr County.

The post oak areas do not occur on the limestone formation of the Edwards Plateau but occupy the sands and gravels of the Carboniferous formation, the Cross Timbers, the Granitic country, river terraces, and the Lignitic belt already described. Such areas occurring north of the Edwards Plateau are constantly intermingling with the limestone types of timber and in reality represent an associate type of the hill timber. Post and black jack oaks constitute the chief species, the former being larger and more abundant. In the Llano country and as far south as Fredericksburg, in Gillespie County, quite heavy stands of post oak are common. They increase in abundance northward toward the Cross Timbers and the Carboniferous formation.

The most valuable of all the hill types are the cedar brakes, where mountain cedar* forms pure stands on arid, crumbly, limestone hills and slopes. Few regions of the United States produce more commercial cedar than the Edwards Plateau and the country to the north of it. Mountain cedar is closely related to the red cedar (juniper) of eastern Texas. The typical cedar brake is an almost impenetrable thicket with branches closely interlaced and growing to the ground. The brakes formerly contained many trees over one foot in diameter and capable of producing poles thirty or more feet in length. Such trees are still found in isolated brakes not yet lumbered and often growing in mixed



Mesquite, Cedar, and Oak in Burnet County.
(Note the fire burning in a cedar brake.)

forests on lower lands. The dense cedar brakes in general contain shorter and more scrubby timber, and for ten or more miles surrounding cedar shipping points trees of large size are seldom found. As a post tree cedar is still abundant and of suitable size for this use. The brakes are not cut clear and much growth under two and one-half inches in diameter is generally left. This small material grows rapidly after being released and often becomes merchantable in five to eight years unless fires burn these cut-over areas, in which case they are apt to revert to mixed oak and other growth. It is the common belief that cedar areas are increasing rather than diminishing as a result of cut-

*For further information, see Bulletin 207, U. S. Department of Agriculture, Washington, D. C., entitled "The Cypress and Juniper Trees of the Rocky Mountain Region."

ting, since there is a tendency for cedar not only to maintain itself on land occupied by it but to take possession of land cleared of oak and other species.

Cedar brake fires are the most disastrous to which any Texas woodlands are subject. It is estimated that in three counties alone, Burnet, Blanco and Llano, 6000 to 8000 acres a year burn over. These fires are started carelessly or intentionally by irresponsible persons and are fatal to cedar since it is killed by even scorching the leaves or the inflammable, stringy bark. Fires often start in cedar operations and the burning tips are carried by the wind to kindle new fires at points far distant. Sumac takes possession of burned areas and is followed by mixed hardwood brush or, in some cases, by cedar again. Birds are almost the sole means of the spread of cedar or its renewal on the same land since this class of tree never sprouts from the roots. The sentiment of farmers and ranchmen is strongly against burning the woods. It is decidedly unsafe, in cedar sections, for one to be caught setting out fires since the brakes furnish income to many land owners and wages to large numbers of operators.

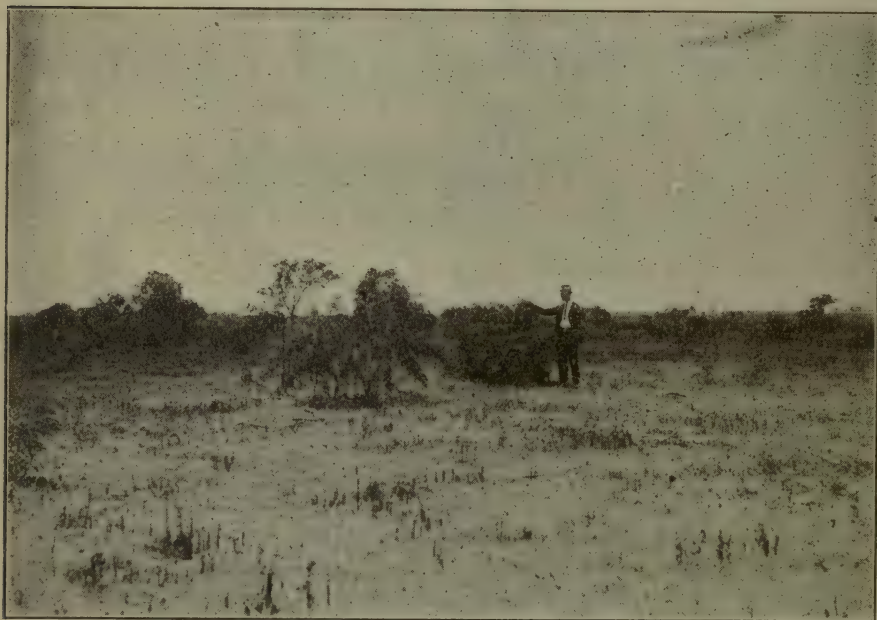
No estimates are available as yet to show the annual output of cedar or the amount of available cedar in this great region. The yards at Marble Falls alone furnish about 300 cars a year. Similar yards are located along all lines of transportation in the region. Most of the cedar is cut into fence posts and poles, which bring upward to 15 cents and 60 cents each, respectively, and are shipped to dealers all over Texas. Timbers of larger size than six inches in diameter and twenty feet in length are generally sold by the linear foot.

Mountain cedar occurs upon all of the hilly or rough portions of the limestone areas, from Palo Pinto County southward to the headwaters of the Medina, Frio, and Nueces Rivers and thence westward over all of the drainage breaks and escarpments as far as the Devil's River in Val Verde County. Much of this territory, however, does not contain cedar of merchantable size or quality. The most extensive operations in cedar are along the Colorado River breaks from Austin to the San Saba country. There are said to be large quantities of this timber in Val Verde and Edwards Counties which are awaiting means of transportation in order to market. Cedar is scattered to the northwestward and is found in the Breaks of the Plains. Rocky Mountain species probably take the place of mountain cedar in these counties, as it does in the Palo Duro Canyon of Briscoe, Randall, and Armstrong Counties and in the Trans-Pecos region.

Prairie Timber.

It is hardly correct to call the woody growth occupying the level prairie sections by the name of timber. Yet a most startling encroachment of forest trees has taken place upon level lands formerly occupied solely by grass vegetation. In almost every section of North-Central Texas this phenomenon is taking place. While the spread of timber upon the uplands and eroded areas is gradual and persistent, it is no

more noticeable than upon the level prairies. Within the last twenty-five or thirty years the transformation has been so marked as to become a matter of common discussion. Every old resident can point out thickets of oak or mesquite, and even extended timber belts, which in the years gone by did not exist. This is abundantly true in Williamson, Burnet, Lampasas, Coryell, and the counties north and west in the flats and basins of the Red Beds country. Over more limited areas it is equally true north and south from Dickens County to the Breaks of the Plains. For years the prairie grass unweakened by overgrazing of stock, and aided by frequent grass fires, held all woody growth successfully in check. Conditions are now reversed and the forest areas are extending downward from the ridges and mesa tops and across the



Mesquite Encroaching on Prairie Land—Colorado County.

open prairies. There are noticeable examples of gradation in ages and sizes of trees, from the oldest on the summits and rough soils from whence the invasion came to the youngest spreading out upon the flats.

Among the tree species which are taking part in this invasion, mesquite is perhaps the most widely abundant. Essentially an occupant of flat, prairie lands, mesquite is rapidly taking possession of wide areas throughout this entire region and in addition is becoming a marked feature of the Edwards Plateau hills. In the great agricultural regions of the Black and Grand Prairies mesquite is also making its home and is spreading to the Lignitic country of the East Texas Timber Belt. Its manner of growth is habitually in pure, orchard-like stands, other

species of trees and shrubs later entering to form mixed stands. The final result of mesquite encroachment on the flats and prairies is a fairly heavy cover of vegetation consisting of mesquite, various oaks, of which live and mountain oaks are perhaps the most important, and other species.

Importance of the Spread of Timbered Areas.

The encroachment of timber growth on the pasture lands of the region is not viewed without some misgiving, since the grasslands are slowly being reduced in area. However, no great hardship to land



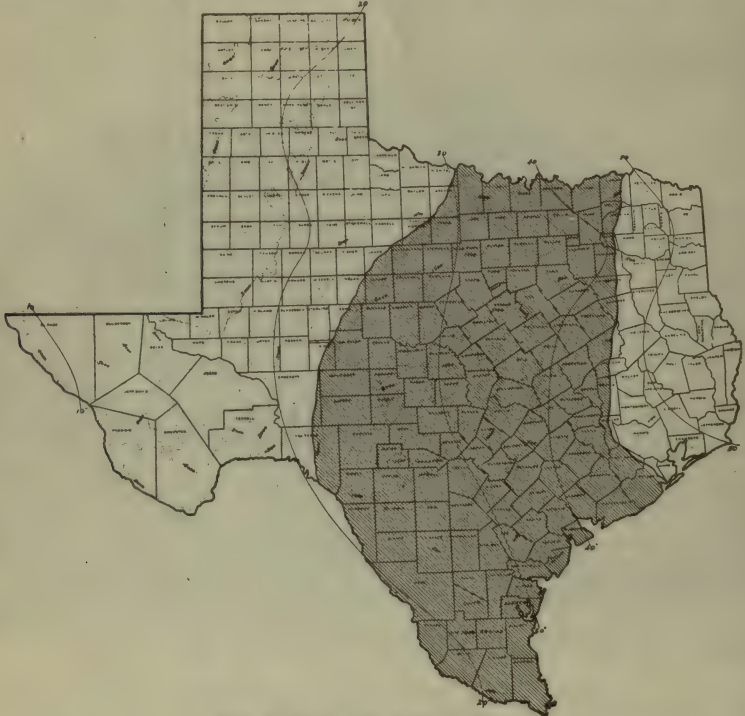
Live Oak Area in the Coastal Prairie of South-Central Texas.

owners is as yet evident. The open stands of timber will not for a long time, if ever, destroy the supremacy of grass vegetation and many distinct benefits from the forest cover are recognized. Among these are the benefit of partial shade as well as forage for stock, greater abundance of fuel wood, fence posts, and other material for ranch and farm homes, and protection of soils and water supplies. Perhaps of all these the influence of an increasing percentage of forest cover on temperature, soil, and water distribution will prove in the long run to be most important. By increasing the transpiration of moisture through the leaves there is a tendency to mitigate intense heat and equalize temperatures. The forest vegetation accumulates a covering of humus on the soil which,

aided by the root systems of the trees, absorbs rainfall and prevents rapid run-off of water, thus checking erosion and causing a more constant flow of water from springs and streams.

LIVE OAK AREA.

Live oak has already been mentioned as occurring throughout the Edwards Plateau and the regions to the north. Since this species is essentially an occupant of the coastal prairie in other Southern States, its adaptation and wide distribution in Texas are quite remarkable. (See Map 8.) Live oak grows to great size and in compact bodies or clumps on the flat prairies of the Gulf Coast from Brazoria and Fort



Map 8—Live Oak Area in Texas.

Bend Counties westward to the Nueces River, and in smaller clumps or as scattered trees bordering the waterways of the entire Rio Grande country. Northward from the coastal prairie the live oak is one of the most abundant species of the Edwards Plateau, forming dense thickets or growing with mountain cedar, mesquite, and other oaks of low growth. In Edwards and eastern Val Verde Counties live oak forms low shrub-like thickets, in places covering 90 per cent of the area. About springs and along streams it is a common tree northward nearly to the Breaks of the Plains and the Red River. On the compact soils of the Black and Grand Prairies it is one of the few species to gain a substantial foothold. Aside from its large size in the south coastal

prairie, live oak becomes a tree of great diameter and spread along the Colorado River and in the San Saba country. Native trees two or three feet in diameter are not uncommon along the roadsides, streets of towns and cities, and in private grounds throughout Central Texas.

The presence of live oak under the varying conditions found in Central Texas from the Coast to the Red River is no more remarkable than its absence in the eastern counties. Although found in the western extension of the Lignitic belt, it is excluded from the bottomland forests as well as from the uplands throughout the main body of the Lignitic belt and from the pine and coastal regions of eastern Texas. It is spreading, however, from its center of most prolific growth in the south-central coastal prairie and may at some remote time become a feature of the southeastern prairies.

Some of the largest live oak timber areas in the South Texas counties have been cleared for cultivation. The extension of live oak to new prairie areas, however, probably offsets the areas cleared. Much of this prairie soil is too valuable to permit of forest growth, so that larger areas will probably be cleared each year and the live oak in South Texas will be properly confined to stream borders and poorly drained areas not capable of cultivation. The timber although not of great commercial importance, furnishes vast quantities of fuel and other material for home use.

RIO GRANDE PLAIN CHAPARRAL.

This region embraces the arid or semi-arid territory lying south of the escarpment of the Edwards Plateau, between the Gulf Coast and the Rio Grande River. It is commonly known as the Rio Grande Plain. The northern portion, however, comes well within the post oaks of the western extension of the Lignitic belt and the area of live oak timber. True chaparral conditions more properly extend southward from the Nueces River. The Rio Grande country is distinctly a forested belt, more than one-half the total area being covered with some form of woody growth. Some seventy to eighty species of small trees and shrubs are found, none of which occur in the Atlantic type of forest, and fully one-fourth of which belong to the bean family. It is a vegetation of meager foliage, furnishing little shade, and growing in open stands with prickly pear. Along the streams or benches and the dry arroyas, mesquite grows at its best, and scraggly trees a foot or more in diameter are not uncommon. Live oak forms a fringe along many streams and reaches fair proportions. The dry uplands are in general about one-half covered with mesquite, white brush, prickly pear, huisache, acacias, and other species of thorny, scrubby growth from three feet to eight feet in height. Among those which grow to valuable size are mesquite, huisache, Texas ebony, catsclaw, retama, and green barked acacia, all members of the bean family. Along the lower course of the Rio Grande River a number of species are of considerable commercial value and find a market among the wood using industries of Texas. Among these are *lignum vitae*, Mexican madrona, palmetto, Mexican

persimmon, Mexican walnut, palo blanco, Texas ebony, Texas catsclaw, leucaena, devil's claw, coral bean, huisache, mesquite, koeberlinia, and long stalk willow.

During recent years the spread of chaparral growth northward from the Rio Grande country has been remarkable. Large areas now wooded are known to have once consisted of arid plains. This enroachment undoubtedly tends to lessen the capacity of the country as a cattle range, although a dense grass cover appears to occupy most of the land, except during periods of severe drouth.

ROCKY MOUNTAIN TYPES.

The area in Texas occupied by Rocky Mountain species includes those isolated foothills and mountains of the Trans-Pecos region which range from 6000 or 7000 feet to 9500 feet in elevation. At such altitudes extreme aridity is offset by reduced annual temperature and increased rainfall, thus giving sufficient moisture to maintain tree growth in favorable situations. Three chief mountain groups are recognized; namely, the Chisos, Davis, and Guadalupe ranges. Within these mountain masses there are two important types; the timber of the foothills and slopes, and the timber of the summits and high canyons.

Timber of the Foothills and Slopes.

This type includes some species found in the Edwards Plateau but in general they belong to regions of higher elevation and are common to the southern Rocky Mountains. The pinon pine is most widely distributed and is of the most importance. It is found occurring sparsely on the slopes of the higher mountains, on some of the northern slopes and in the canyons of the Edwards Plateau west of the Frio River, and in the Pecos and Palo Duro canyons. The species probably reaches its best development in the Chisos Mountains of the Big Bend country. With the pinon pine are found several species of cedar (juniper), Emory oak, and other species of little value.

Timber of the Summits and High Canyons.

The tree growth in this type consists of isolated islands of Rocky Mountain species, of which western yellow or bull pine, Douglas fir, and limber pine make the largest growth. Such timber is limited to the Guadalupe, Davis, and Chisos Mountains. Associated with these are Emory oak, cedar, and other species. The Emory oak is said to become a tree of from two to four feet in diameter and sixty feet in height, but the growth of all species is generally short and scrubby. Little information is available as to the abundance and uses of the various Rocky Mountain trees in the Trans-Pecos region. It is probable that much of it has already been cut in connection with the mines and ranches. As a protection to steep slopes and for fuel and posts, timber in this arid region is of great importance and its extension should be encouraged by every means possible.

THE COMMERCIAL POSSIBILITIES OF MESQUITE.

By H. B. Krausz.*

The Forestry Department made an extensive reconnaissance of the mesquite areas in South Texas during the summer of 1916. The study had for its object a determination of the possibilities of mesquite as a commercial timber and attempts to answer questions relative to the location and extent of areas of suitable growth, the size and quality of the timber adaptable for manufacturing purposes, the available quantity on areas located with reference to cheap logging, and the probable cost of logging and shipment to San Antonio for manufacturing purposes.

DISTRIBUTION AND GENERAL CHARACTERISTICS OF MESQUITE.

It is probable that mesquite first invaded Texas, from the region adjacent to Matamoras in Old Mexico, a century and a half ago. Since that time its spread has been very rapid. At present a more or less scattered growth of mesquite is found over practically the entire State, except the Great Plains proper in Northwest Texas and that portion of eastern Texas lying east of the lower reaches of the Brazos River, the Navasota River throughout its entire length, and the upper reaches of the Trinity River and its North Texas tributaries. (See Map 9.) The rapidity and extent of its spread are due to the abundance of its seed, the vigor of the young trees, lack of competition between the seedlings and native grasses because of overpasturing and burning, and the fact that live stock are the primary agents in transporting the seed. Mesquite is not able to compete with other native trees for the more favorable situations but is forced to occupy low or level areas of fine, compact, less porous soils. Notwithstanding the unfavorable growing situations, however, sufficient moisture is supplied to the tree through its heavy, extensive root system. It is not uncommon to find the greater proportion of a mesquite under rather than above the ground. Unusually moist soils, on the other hand, seem to limit the occurrence of the mesquite. This is particularly true in the southern portion of its range. Areas immediately adjacent to the streams support a growth of native hardwoods, the largest mesquite occurring on what might be termed the second benches and dwarfed, scrubby mesquite occupying the higher, drier sites. The inability of mesquite to endure shading, as compared with the native hardwoods, may be another factor operating to exclude the former from the more favorable situations.

Since associated species are almost invariably small in diameter and scrubby in growth, from a volume standpoint mesquite may be said to grow in pure stands. Individual trees sometimes attain a diameter of three feet but by far the greater percentage will average less than one foot. Within its range the heaviest stands and the largest individuals

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are to be found on well drained sites throughout the territory south of the Edwards Plateau to the lower Rio Grande River and north of the Plateau through the Central Denuded Region to the Red River. In its more northern extension, even within this range, the trees become more dwarfed and the stands more scattering. In general the mesquite is decidedly poor in form. Short, crooked stems with long, sinuous branches give the tree a widespreading, straggly appearance. Mesquite areas remind one most forcibly of long neglected orchards. It is practically impossible to secure straight logs as long as six to eight feet, the average being more nearly two feet. Excessive crook is the primary



Map 9—Distribution of Mesquite in Texas.

1—Area of heavier growth. 2—Area of scattered growth.

factor in limiting the possible commercial use of the timber. Diameter growth is comparatively rapid, ranging from four to six years to the inch. Height growth is fairly rapid during early life but quickly culminates and further crown expansion is lateral. This characteristic gives a mesquite stand the appearance of even age although trees of practically all ages may compose it.

The wood, particularly the heartwood, is hard, brittle, close grained, and extremely durable. At any age the narrow band of sapwood remains practically the same width. Thus, in later life, the proportion of heartwood to sapwood is greatly in excess. In color the heartwood

is reddish-brown, and the sapwood yellowish-white; both are capable of being highly polished. This last quality would render the wood eminently fitted for a furniture wood were it not for the difficulty encountered in securing suitable sizes. The hardness also makes veneer cutting difficult. The brittleness of the wood unfits it for a number of uses where otherwise small sizes could be utilized. Seasoning mesquite timber is a long, tedious process. Sawed specimens after several years under cover have been found to be cured only on the outside. Timber cut from mesquite, if of any size, is usually defective. The brittleness of the wood, together with the widespreading crown renders the tree peculiarly liable to windshake. Trees of every age, more particularly the older individuals, are attacked by wood boring insects, their galleries traversing the wood in all directions, thus rendering much of it unfit for manufacturing purposes.

It must not be considered, however, that mesquite is worthless for manufacturing purposes. The wood, because of its hardness and susceptibility to polishing, is eminently fitted for the manufacture of small, turned articles such as gavels, plaques, goblets, rings, trays, inlay, small tool handles, which are not to be subjected to impact stresses, and various other wood novelties. The wood has a possible use as parquetry flooring because of its hardness. Paving blocks made of mesquite are practically indestructible and have been known to last for at least twenty-five years without appreciable deterioration. Heavy wagon felloes for use in arid regions may be made from mesquite as the wood does not swell, shrink or warp, and the size of the felloe would offset any weakness due to its brittle character. In all the above uses short lengths can be handled to advantage. Locally, the larger limbs and branches are used for fence posts and fuel while the main trunks are burned in the fields when new land is cleared.

The by-products of mesquite are important in themselves. The pods furnish excellent forage for stock. Mucilage can be made from the gum; dyes from the sap; tannic acid from the resin; vinegar from the fermented juice of the fruit, and as a bee pasture the long persistent flowers produce an excellent grade of honey. It is estimated that thirty pounds of potassium salts per acre may be secured from burned brush.

REGION COVERED.

The region south, southwest, and west of San Antonio, embracing the counties of Atascosa, Bexar, Dimmit, Frio, LaSalle, Live Oak, McMullen, Medina, Nueces, San Patricio, Uvalde, and Zavala, was examined both because of its accessibility to San Antonio and because it was considered an optimum region for mesquite. The twelve counties enumerated above total 14,915 square miles in area and are drained by the Atascosa, Frio, and Nueces Rivers and their tributaries. The annual rainfall averages between 20 and 30 inches. It was considered that mesquite within this region would represent maximum conditions because of the presence of large areas of fertile, bottomland soils.

METHOD OF RECONNAISSANCE.

Preliminary information as to the location of areas of suitable growth was obtained through correspondence with land holders and other persons interested in the study. In the field the line of the San Antonio, Uvalde & Gulf Railroad furnished an excellent means of further determining the location of areas of possible commercial significance. A strip of country, ranging from one to fifteen miles in width, could be seen from the trains and its topography and the general character of the tree growth noted. When stands of timber which gave promise of being suitable for manufacturing purposes were found, headquarters were established in the nearest town. Local residents, thoroughly familiar



A Mesquite Paved Street in San Antonio.

with the surrounding country, were consulted and the location and size of all such areas definitely determined. Horseback and automobile transportation were then used to reach these areas and make a detailed reconnaissance. Local information, either through misunderstanding or over-estimation, was for the most part unreliable. Stands of timber described as being composed of trees three feet through were non-existent. In almost every case such areas as were said to be covered with a growth of large sized timber supported a growth of small timber with here and there at wide intervals a large, over-mature individual. In this connection it may be said that trees of more than nine to ten inches average diameter at breast height are apt to be stag-headed and show dead or

dying branches even in the lower portion of the crown. Such timber is usually unsound. More than 150 miles of horseback and 500 miles of automobile travel (one trip alone being entirely across McMullen County from Three Rivers to Fowlerton) furnished ample basis, however, upon which to form the conclusions shown in this report.

The volume per acre, average size, and the quality of the timber on the areas examined were determined by the use of circular sample plots. All sound trees on the plots were tallied in logs by center diameters and log lengths. No defective timber and no logs under two inches in diameter at the center and two feet long were tallied.

MESQUITE AREAS.

Mesquite is found in all sections of the region covered but the character of the timber is decidedly variable. The greater portion of the area is covered with a shrub-like growth of mesquite which stools out at the ground into a number of slender, crooked stems. Entire sections, particularly the higher and drier situations, are occupied by such growth in association with huisache and black chaparral (catsclaw). The mesquite trees in this type are but little taller than a mounted man and average less than two inches in diameter. Along the streams, where mesquite would be expected to attain its best development, the species is crowded out by the native hardwoods, such as elm, ash, hickory, and live oak. In a few of these situations, however, mesquite of fair size and quality is found, but the areas are so small and so widely scattered as to make the cost of logging and delivery to a mill prohibitive. When the controlling factors of volume per acre, area of tract, size and quality of timber, and accessibility are considered, the total stand of mesquite with commercial possibilities in the region is exceedingly small.

Five areas, from one and one-half to three miles distant from the railroad, were found to contain fairly large, compact bodies of mesquite. The timber on each is of average size for the species and of good quality. Volumes per acre, while low, are probably as high as could be secured for the species. Since it is feasible to locate a mill along the railroad in the vicinity of the timber, the haul would in no case be more than three miles; one of the tracts (Odem) is bisected by the railroad and the outer boundaries of suitable timber are not more than one and one-half miles from the track on either side. The ground on the areas is firm and would permit of easy logging. Woods labor in the different sections should be cheap as the cutting may be done by Mexicans. Supervision, of course, would be more exacting.

Details concerning the five specific areas are as follows:

County.	Nearest Town. Miles.	Haul to Railroad.	Area. Acres.	Volume Per Acre. Board Feet.	Total Volume. Board Feet.
San Patricio.....	Odem, 3.....	1-2	4,000	823	3,292,000
Uvalde.....	Uvalde, 2.....	1-2	1,800	735	1,323,000
Uvalde.....	Crystal City, 2.....	1-2	2,000	410	820,000
Live Oak.....	Three Rivers, 5.....	2	300	452	135,600
San Patricio.....	Mathis, 4-6.....	2-3	1,200	387	464,400
Total.....			9,300		6,035,000
Average.....		1.7		561.4	

In preparing these estimates it was found that the log run averaged only from three to four inches center diameter by three feet in straight, clear length. A fairly large number of logs, however, from six to eight feet long in the smaller diameter classes and from two to three feet long in the larger diameter classes, were tallied. The short log lengths are due to excessive crook; even the main stems would not permit of cutting long logs.

PRESENT LOGGING AND MILLING METHODS.

At present practically no effort is made to log or mill mesquite. The timber is considered of too little value to warrant the labor involved in sawing it. Practically the only raw material secured is where new lands are in the process of clearing. The trees are grubbed out of the ground, the work being paid for on an acre basis. The large limbs and branches are utilized for fence posts and fuel; the trunks are burned in the field. As labor is cheap such clearing is not an expensive process.

Two small mills, more of the planing rather than the sawing type, are located at Batesville, Zavala County, ten miles from the railroad, and at Fowlerton, LaSalle County. The mill at Fowlerton cuts small timber to fill local orders for mesquite novelties, which are turned and made in the plant. The raw material received is in the shape of cordwood of the larger sizes. The mill at Batesville is about of the same type but was not in operation at the time of the examination. Cordwood sawing is practically unthought of as the wood is so brittle that the small sizes of the sticks used can be broken more easily than sawed.

PROPOSED LOGGING AND MILLING METHODS.

Areas of suitable timber should be logged systematically, since it is obvious that grubbing out the trees in intermittent clearing operations, which is the present source of mesquite wood, cannot furnish sufficient raw material to enable a mill to run continuously. Locally the belief prevails that in logging mesquite it is not practicable to saw the timber. Experience in other regions where hardwoods comparable to mesquite are cut, however, shows this method to be entirely feasible. A change in the class of material utilized is also necessary. Only the branches and other small material are now used. All logs which measure at least two inches in diameter at the center and two feet in straight, clear

length, and are free from defects due to insects or other injuries and decay, should be set aside and hauled to a mill equipped to handle them. Such a procedure would insure the receipt at the mill of a class of operating expenses. The mill operator would be using such material as timber which could all be utilized, thus minimizing waste and reducing is now wasted while discarded portions of the tree could still be used for fence posts and fuel.

In milling a high grade hardwood, more particularly mesquite, small, local mills are apt to be inefficient. The extreme hardness of the wood, together with the small sizes of the logs, make sawing difficult. Cut stock will show wane and be of different dimensions at the extremes, due to slipping of the piece when being sawed. As a consequence the value of the finished product, even in squared bolts as mesquite would be used, is out of all proportion to the cost of production. Milling methods must, therefore, be efficient.

A single circular saw portable mill, of the type used in the northern hardwood regions, should solve the problem. Such a mill would be equipped with a circular saw, not more than 30 inches in diameter, a belt driven carriage on which the log is clamped and carried against the saw, and a small boiler to furnish the power necessary to drive both the saw and the carriage. Clamping the log to the carriage insures uniformity in sawing which is now so lacking in the cut timber examined. A mill of this type could be set up at points along the railroad easily accessible to areas of suitable timber, the raw material hauled in for sawing, and the finished product, squared bolts of various dimensions, shipped to the manufacturers. When the available timber is cut out locally, the mill could be dismantled and shipped to another location. Although the capacity of such a mill is about 10,000 board feet daily in average hardwood timber, this output would not be possible in mesquite. Not more than 2000 board feet, with an average of perhaps 1200 feet, could be cut daily. At this rate and based upon 250 operating days annually, the present available stand should insure a life at least twelve years to a mill of the type mentioned.

Another feasible plan would be to establish a mill at San Antonio as a receiving point. Local buyers, purchasing raw material in the round, could ship to the mill such timber as would be suitable for sawing. This mill might be equipped with two circular saws, rather than one, as is the case with the local portable mill, since shipping to one central point would mean the receipt at the mill of a comparatively large volume of timber. Buying locally and shipping only selected timber would reduce freight charges on unsuitable material. Shipping timber in the round would, of course, mean paying freight on a certain quantity of unavoidable mill waste, but this excess charge would probably be balanced by a difference in the freight rates on finished and unfinished products. In this connection it was not possible to obtain a definite rate on squared bolts of mesquite lumber, but the cordwood rate is well recognized and reasonable.

With the second of the proposed plans, and to a certain extent with

the first plan, there would be small areas of timber and scattered trees available which are not included in the figures shown as the present stand. Owners could thus receive revenue from their timber when clearing land. Buyers for the central concern could accumulate small amounts of timber at railroad points and ship whenever carload lots were on hand.

LOGGING COSTS.

The average cost of logging and delivering mesquite to a local mill should approximate \$11 per M board feet, divided as follows:

Stumpage (4 cords at 50 cents each).....	\$ 2 00
Cutting (including supervision).....	5 00
Hauling (average haul 1.7 miles and four trips daily).....	4 00

Total per M board feet.....\$11 00

If the raw material is shipped to one central mill the following approximate figures should be added to the above cost:

Loading (4 cords at 50 cents each).....	\$ 2 00
Freight (\$1 per cord average).....	4 00

Total per M board feet.....\$ 6 00

MILLING COSTS.

It is difficult to estimate the cost of milling mesquite as no data could be obtained in the region. Based upon portable mill operations in such of the hardwood regions as are comparable, the average cost should not exceed \$10 per M board feet.

From the above figures the average cost of logging and milling 1000 board feet of mesquite timber should range from \$21 to \$27, depending upon the location of the mill.

SUMMARY.

Since logs less than two inches in diameter at the center by two feet in straight, clear length cannot be utilized, approximately 90 per cent of the total area of the region studied is covered with a growth of unmerchantable timber.

The possible commercial stands comprise an area of approximately 9300 acres, with an average volume of 561.4 board feet per acre, and a total volume of 6,035,000 board feet.

The log run will average 3-4 inches center diameter by 3 feet long.

Trees more than 9-10 inches in diameter at breast height are usually unsound, either through windshake, insect injuries or decay.

Efficient logging can be done cheaply in comparison to the possible value of the finished product.

In order to minimize costs, unsuitable raw material must be culled out before hauling or shipping to the mill.

The mill may be a local portable one or a stationary one located at a central receiving point like San Antonio.

The cost of efficient logging and delivery to the mill should range from \$11 to \$17 per M board feet, depending upon the type of mill.

Efficient milling costs should not exceed \$10 per M board feet.

The finished product could be manufactured in San Antonio for approximately \$27 per M board feet. The finished product, sawed at the local mill and delivered in San Antonio, might cost more, depending upon a possible increase in the freight rate on finished material over the cordwood rate.

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of the

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No. 3

**First Annual Report
OF THE
State Forester**

J. H. FOSTER, State Forester

H. B. KRAUSZ, Forestry Assistant

GEO. W. JOHNSON, Agent for East Texas



BULLETIN 4.

DEPARTMENT OF FORESTRY

AGRICULTURAL AND MECHANICAL COLLEGE

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FIRST ANNUAL REPORT

of the

STATE FORESTER

INTRODUCTION.

During the past ten or fifteen years the importance of a State forestry policy with sufficient appropriations to make the work effective has been recognized by the majority of States. In bringing about wise forest legislation, securing protection of forest lands from fire, encouraging reforestation, establishing State forests and promoting an interest in the growing and care of trees, greater advances have been made during the last 15 years than during all the previous history of the country. Large sums of money are being appropriated by the States for forestry purposes. The legislative enactments made along forestry lines, the liberal appropriations passed, the exhaustive systems of fire protection administered and the general plans undertaken for the advancement of forestry knowledge and interest are a matter of profound amazement to one who is not familiar with the forest policies of different States. In most States forest fires are no longer permitted to run unchecked but are extinguished before they have covered much ground. In addition every conceivable kind of measure is now brought into service to prevent fires from starting. Fire control is operated on a systematic basis with the result of saving millions of dollars annually from fire losses. There are State nurseries where trees for planting are grown by the millions and sold to residents within the States at cost prices. Some States actually do the planting for their citizens charging only the cost of the stock and the actual expenses of the planting. Large areas are being purchased as State forests to be managed by the States in order to conserve the water supplies, provide future timber for local use and to serve as examples of the proper handling of forest lands. Farmers' woodlots are operated on a financial basis by advice and practical assistance of State forestry agents. Laws to protect roadside trees from abuse and to encourage planting are well recognized. In some States the planting and protection of young growth are encouraged through special measures to relieve young forests from burdensome taxation. State forestry is being developed to serve the public along many lines. Much of the farsightedness and wisdom of the present day forest policies in the States is due to the efforts of the National Government which offers aid in fire protection, woodlot management and along other lines to States which maintain suitable forest policies.

The following is a list of the States which are well advanced along State forestry lines and a list of their appropriations for the year 1916:

California	\$ 27,900	New Jersey	\$ 43,000
Connecticut	15,000	New York	177,800
Idaho	18,000	North Carolina	23,000
Kentucky	15,000	Ohio	24,000
Maine	74,300	Oregon	30,000
Maryland	14,000	Pennsylvania	315,000
Massachusetts	83,000	Vermont	19,500
Michigan	125,000	Washington	37,500
Minnesota	117,000	Wisconsin	35,000
New Hampshire	38,800		

The average annual appropriation of these States is \$64,884.

Many other States have made notable progress in forestry within the space of a few years, among which Texas with its annual appropriation of \$10,000 is by no means least. The prairie State of Indiana provides \$8,000 for forestry work, Colorado \$5,000, Montana, \$6,000, North Dakota \$5,000, Rhode Island \$3,000, South Dakota \$9,500, Tennessee \$4,000, Virginia and West Virginia \$10,000 each, and treeless Kansas \$3,750 for maintaining a State forest nursery. Louisiana has during the present year inaugurated a forestry policy and \$20,000 a year will be available. It is notable that some of the smallest States as well as States where the forest areas and forest industries are insignificant make large forestry appropriations. The States which are most liberal in their appropriations appear to be those like Pennsylvania, Michigan, Wisconsin and others, which have found their forest resources verging on exhaustion and are now taking liberal but belated measures to restore them.

The only States in the country which exceed Texas in the amount of lumber manufactured annually are, Washington, Louisiana, Mississippi, North Carolina and perhaps Arkansas. In size Texas exceeds all others and being located so that most of the State is far removed from sources of timber the importance of maintaining its timber supply is greater than in most other States. Few people realize the extent of forest lands in Texas or the value of the industries dependent upon them. The timber belt of Eastern Texas alone is greater in area than the total area of many States or even groups of States. In tree planting or the management of farm woodlots the enormous territory of central and western Texas merits equally as much consideration as does eastern Texas or any other State. Based on land area, population or forest resources Texas should be among the foremost to advocate and carry out the principles of forestry.

In State forestry activity, Texas stands today among those States whose work is just under way. There has been a group of earnest and far-sighted citizens in Texas who have worked zealously for many years for the inauguration of a State forest policy. This culminated early in 1915 in the formation of the Texas Forestry Association whose members

were largely instrumental in securing the passage of the Forestry Act at the last session of the Legislature. Among the chief supporters of State forestry in Texas are those who have studied and become familiar with the State's vanishing forest resources or are familiar with the development of forestry in other States and abroad. Investigators, scientists and editors contributed to our knowledge of forest resources and conditions through the journals, bulletins and newspapers. A number of valuable studies have been made in Texas by agents of the Government Service. The time was indeed ripe for action in Texas and the passage of the Forestry Act by the 34th Legislature was an achievement which is not only appreciated by the people of this State but is well recognized throughout the country.

TEXAS FORESTRY LAW.

Chapter 141, Laws of 1915.

Section 1. There shall be appointed by the Board of Directors of the Agricultural and Mechanical College of Texas a State Forester, who shall be a technically trained forester of not less than two years experience in professional forestry work; his compensation shall be fixed by the said Board at not to exceed three thousand (\$3,000) dollars per annum, and he shall be allowed reasonable traveling and field expenses incurred in the performance of his official duties. He shall, under the general supervision of said board, have direction of all forest interests and all matters pertaining to forestry within the jurisdiction of the State. He shall appoint, subject to the approval and confirmation of said board, such assistants and employes as may be necessary in executing the duties of his office and the purposes of said board, the compensation of such assistants and employees to be fixed by said board. He shall take such action as may be deemed necessary by said board to prevent and extinguish forest fires, shall enforce all laws pertaining to the protection of forest and woodlands, and prosecute for any violation of such laws; collect data relative to forest conditions, and to cooperate with land owners as described in Section 2 of this Act. He shall prepare for said board annually a report of the progress and condition of State forestry work, and recommend therein plans for improving the State system of forest protection, management and replacement.

Section 2. The State Forester shall, upon request, under the sanction of the Board of Directors, and whenever he deems it essential to the best interests of the people of the State, co-operate with counties, towns, corporations or individuals in preparing plans for the protection, management and replacement of trees, wood lots, and timber tracts, under an agreement that the parties obtaining such assistance pay at least the field expenses of the men employed in preparing said plans.

Section 3. The Governor of the State is authorized upon the recommendation of the Board of Directors to accept gifts of land to the State, same to be held, protected and administered by said board as State forests and to be used so as to demonstrate the practical utility of timber culture and water conservation, and as refuges for game. Such gifts must be

absolute, except for the reservation of all mineral and mining rights over and under said lands, and a stipulation that they shall be administered as State forests.

The Board of Directors shall have the power to purchase lands in the name of the State, suitable chiefly for the production of timber, as State forests, using for such purposes any special appropriation or any surplus money not otherwise appropriated, which may be standing to the credit of the State forestry fund.

The Attorney General of the State is directed to see that all deeds to the State of land mentioned in this section are properly executed before the gift is accepted or payment of the purchase money is made.

Section 4. All monies received from the sale of wood, timber, minerals or other products from the State forests, and penalties for trespassing thereon, shall be paid into the State Treasury and shall constitute a State forestry fund, and the moneys in said fund are hereby appropriated for purposes of forestry in general, under the direction of the Board of Directors.

Section 5. For the maintenance, use and extension of the work under the Board of Directors, and for forest fire protection, there is hereby appropriated the sum of ten thousand (\$10,000) dollars annually out of any moneys in the State Treasury not otherwise appropriated, to be placed to the credit of the State forestry fund.

Section 6. Co-operation with Federal Forest Service. The Board of Directors may co-operate with the Federal Forest Service under such terms as may seem desirable.

WORK OF THE FORESTRY DEPARTMENT.

Co-operation With Federal Government in Forest Fire Prevention.

An Act of Congress known as the Weeks Law (March 1, 1911) authorizing the acquisition of lands on the watersheds of navigable streams for the purpose of conserving their navigability, also enables the Secretary of the United States Department of Agriculture to co-operate with any State, when requested to do so, in the protection from fire of the forested watersheds of navigable streams. In order to co-operate under the terms of the Weeks Law, each State must have provided by law for a system of forest fire protection. In no case shall the amount expended in any State by the Federal Government exceed in any fiscal year the amount appropriated by that State for the same purpose during the same fiscal year. The Law is administered by the Forest Service of the United States Department of Agriculture under an agreement between the Secretary of Agriculture and the State. No State receives more than ten thousand (\$10,000) dollars in any one year. The interpretation of what constitutes a navigable stream is the report of the Chief of Engineers of the United States Army on the navigability of streams. In general a broad and liberal interpretation has been allowed. The expenditures made by the Federal Government are exclusively for the salaries of Federal patrolmen and lookout watchmen. The States' expenditures, which are to offset those of the Federal Govern-

ment, may include, however, any expenditures for protecting forested watersheds of navigable streams from fire. The State Forester or State officer in charge selects the Federal patrolmen, instructs them in their duties and supervises their work. These patrolmen are paid direct from Washington.

As soon as the office of State Forester in Texas was created application was made to the Federal Government for co-operation in fire protection under the terms of the Weeks Law. A formal agreement was arranged making a Federal allotment of twenty-five hundred (\$2500) dollars available for the calendar year 1916, this amount representing the sum which the State Forester was able to expend for fire protective work during the year to offset Federal expenditures. Since the greater part of Texas is on the watersheds of streams recognized as navigable by the Army Engineers no difficulty was experienced in establishing a co-operative area. The area selected for co-operative fire protection during the year 1916 consists of 30 eastern counties of the State on the watersheds of the Red, Sabine, Neches, and Trinity rivers. These counties were selected in order to establish a unit, approximately 13,000,000 acres, where southern yellow pine prevails and within which forest fire protection is an important issue.

On February 1, George W. Johnson of Tenaha, Shelby County, was appointed an agent of the State Forester to devote his entire time to fire protection work within the co-operative area and to supervise the work of the Federal patrolmen. From February until September 1, Mr. Johnson was engaged in a survey of forest conditions within the co-operative area with particular reference to fire damage and prevention of fires and in an examination of the forest resources of the region.

On September 1, six Federal patrolmen were placed on duty with headquarters at Lufkin, Livingston, Jasper, Longview, Tenaha and Linden. Substitutions and additions will undoubtedly be made before the close of the calendar year. Patrolmen were selected who are interested in fire protective work, who have intimate knowledge of the country and a high standing as citizens in their respective communities. Each patrolman was given a radius of about 25 miles surrounding his headquarters, or 1,256,640 acres, to patrol on horseback. His instructions require him to ride from 15 to 25 miles each day and to meet all citizens and residents, acquainting them with the importance of preventing fires and urging them to co-operate with the State and Federal Government to this end. Each patrolman is supplied with fire notices to post in conspicuous places and with literature to distribute relative to fires and the damage done by them. He is also required to extinguish small fires and to secure the aid of nearby residents to help extinguish others. The patrolmen are conscientious in the discharge of their duties and their daily reports show that the work is meeting with approval throughout their districts. The Agent of the State Forester visits each patrolman at frequent intervals.

The patrol work as here outlined will be continued until December 31, when the allotment made by the Federal Government will be exhausted. A new allotment will be secured from the Government for the year 1917 the amount depending upon the State appropriations available for this work.

At the present time more than 7,500,000 acres out of approximately 13,000,000 acres in the co-operative area established by the Government and the State Forester are being brought under the direct influence of this patrol work. Every resident within each of the patrol districts becomes acquainted with the efforts of the State and Government to prevent the widespread and destructive burning of woodlands. More than 90 per cent of these people have registered their approval. They perhaps have not realized before what damages result from fires or as more than one of them has stated, "What is every man's business is nobody's business." As soon as they learn that the State of Texas is using its efforts to suppress fires, they are willing and glad to assist. When this sentiment develops, it becomes unsafe for irresponsible persons to set out fires and allow them to run at large.

Under the Weeks Law it is possible to secure an allotment of not to exceed ten thousand (\$10,000) dollars annually from the Federal Government when State funds for the same purpose amount to at least the same amount. The State Forester hopes to secure from the Legislature sufficient appropriations so that the entire co-operative area may be patrolled for at least four months of the year. The boundaries of the co-operative area should be extended to include the entire East Texas Timber Belt, and the forest lands of Central Texas, particularly counties where cedar brakes furnish an important revenue and where the maintenance of wooded slopes is important to conserve the supply of water in the streams. The necessity of carrying out other important lines of work by the State Forester makes it impracticable to expend more than 25 per cent of the forestry appropriation on fire prevention work.

Examination of the Forest Resources of Texas.

One of the duties of the State Forester specifically mentioned in the Forestry Act of 1915 is to collect data relative to forest conditions. This work has been carried on throughout the eastern timber belt in conjunction with the fire protective work. The Agent of the State Forester in East Texas has visited every county, talked with county officials, lumbermen, operators in forest products, land owners and others and has made extended trips into the several counties for the purpose of observing first hand the extent of resources and the condition of the forests. It has not been possible in the space of one year to make detailed surveys of conditions and resources although it is planned to do so, county by county, as soon as the work becomes more fully organized and funds and men are available for the purpose. Such detailed surveys will not only cover the great timber belt of Eastern Texas but all the counties where forest products are marketed or where forests exist which should be conserved and properly utilized.

The results of county examinations already made in Eastern Texas, while preliminary in character and lacking the conclusiveness which is possible only by an actual survey of every portion of the counties, have furnished the State Forester with a vast amount of information valuable to the pursuit of his work. Estimates of standing timber and outputs of forest

products by counties as well as the general forest conditions in each eastern county were secured and will be published.

During the year the State Forester has visited almost every section of Texas in order to become familiar with the general forest conditions and the problems needing attention in the future. The most important impression received by this reconnaissance of the State's forest conditions is that Texas, far from being a treeless State, contains minor forest resources in almost every section of its wide domain upon which the farms and ranches are in no small degree dependent. The value of the forests is recognized first of all in those sections where timber is scarcest and looked upon with the greatest indifference where timber is still abundant. Throughout the whole interior part of the State, the scattered forests serve a valuable purpose in stream protection, checking the rapid run-off of water, building up a soil humus, supplying fuel, fence posts and numerous minor products in daily use, reducing the velocity of wind and furnishing shade and rest for man and beast.

At the request of the San Antonio Chamber of Commerce the Forestry Department during the past summer carried on an investigation of mesquite timber in twelve counties of South-Central Texas. The purpose of the study was to determine for the region where mesquite grows to its largest size in Texas the relative abundance of timber of marketable size, the cost of handling and marketing the timber, the condition of the timber and the uses to which it can be put. The commercial value of mesquite wood, where it can be secured in suitable sizes, has long been recognized. Locally it is used for a multitude of purposes, the most important of which are fuel and posts. Shipments in car lots are frequently made to distant points for miscellaneous uses. The quality and beauty of finished wood are well known among cabinet workers and fancy wood users. Fundamental questions concerning the practical utilization of mesquite in fairly large quantities remained to be answered. The investigation carried on during the summer attempts to answer these questions and a report has been prepared for publication.

Tree Planting in Texas.

A bulletin has recently been published by the State Forester as a result of observations and examinations of tree planting conditions and the needs for planting trees in Central and Western Texas. While countless millions of young trees have been transplanted from the woods and bottoms in order to beautify streets and home grounds throughout the State yet tree planting as it should be carried on has barely commenced. Trees should be planted for windbreaks and shelterbelts on the plains, as woodlots for fence posts, fuel and other home uses where suitable native trees are not close at hand and for ornamenting school and home grounds, county roadsides, city parks and streets. Much of the planting in the past has been done without system or foresight. Good judgement has often not been exercised in selecting trees for planting and in properly setting them out. There is much to commend in the efforts of our people to plant trees

but also much to criticise in their tree planting methods and practice. Cities are too often negligent in not taking precautions to protect the street and park trees already planted.

The demand for trees of suitable sizes and species for various kinds of planting is very great in Northwest Texas. Instances without number are recorded where farmers in the Panhandle counties have driven ten miles or more to secure a few black locust sprouts for setting out on their farms. Prairie farms nicely planted with ornamental trees and shelter-belts to protect orchards, gardens and buildings make one of the most beautiful pictures of the plains country. Similar farms without trees, no matter how well the grounds are kept, are positively ugly in comparison. Nearly every farmer realizes this and is anxious to plant trees. Tree planting for fuel, posts and protection from winds, as well as for ornament, is only beginning in this region. The State Forester believes that one of his most important duties is to make tree planting easy for the plains people by establishing one or more State nurseries where large numbers of trees may be grown and distributed at the actual cost of growing them. In no section of Texas or of the United States is there a greater demand for trees than in the Panhandle or is there greater difficulty in securing them. Most commercial nursery dealers are far removed from the region and moreover, they chiefly grow fruit trees and do not handle forest or ornamental trees in sufficient numbers so that they can afford to sell them cheaply. A State nursery would be a tremendous stimulus to tree planting of all kinds and would eventually benefit commercial nursery dealers themselves. The State of Kansas and many other States have long ago established State nurseries in connection with their State Forestry Departments from which trees are distributed at the actual cost of raising them.

Examinations for Cities, Corporations and Individuals.

In accordance with the Forestry Act of 1915 the State Forester has rendered every assistance possible to all interests in the State along various lines of forestry and tree planting work. During the year the Forestry Department has been called upon by officials in Dallas, San Antonio, Denton, Orange and other cities and towns to advise as to the care of their trees or to recommend plans for the improvement and permanent supervision of street and park tree work. In the city of Dallas the assistance rendered has resulted in the appointment of a City Forester to take charge of all street tree work in the city.

The Department has assisted a number of boards of trade and chambers of commerce throughout the State to secure data relative to the carrying out of economic projects involving the use of wood and timber. The study of mesquite was made at the request of the San Antonio Chamber of Commerce. Investigations are also underway which may lead to the use of bois d'Arc and new woods from the Rio Grande country in the making of dyes.

Examinations of city street trees have been made at the request of gas and light companies to determine the causes of injury to certain trees.

Numerous inquiries from private concerns have been settled by correspondence since time has not as yet permitted personal examinations of property of this character except where an agent has been near the ground in connection with other work.

Co-operation with public officials, corporations and individuals in the future promises to demand a great deal of time and attention judging from requests already received and the opportunities for such service which exist. There are a large number of State and county institutions whose directors and superintendents will be glad to receive advice and assistance in planting trees and managing woodland areas. This is also true of private timber land owners, many of whom have already expressed a desire to have studies carried on and plans made for the future protection and management of their holdings. Counties have not as yet taken active measures to secure the assistance of the State Forester but once this field is opened there will be many demands made upon the Department.

Educational Work in Forestry.

At first few people seemed to understand what character of work the Forestry Department was intended to undertake. That it related to trees was well recognized but in what manner and to what class of trees was a matter of speculation. People are now learning that an influence is being exerted by the State to prevent the burning of woodlands in Eastern Texas, to encourage tree planting, to acquaint people with the forest resources and their importance to our prosperity, the value of forests and their care and proper use. Street and ornamental tree planting is receiving a stimulus. People are finding that they are interested in trees in ways not before thought of.

Educational work consists in placing a knowledge of the State's forest resources, conditions and needs before the people and give to those who can best use it all the information and facts resulting from investigations and studies made by the Department. The following have been published during the year and are being given as wide distribution as possible:

Bulletin 1. "Grass and Woodland Fires in Texas."

Bulletin 2. "Tree Planting Needed in Texas."

Leaflet entitled "A Forestry Lesson."

Leaflet on Arbor Day—in co-operation with the Extension Service of the A. and M. College.

Two fire notices, one on cloth and the other on cardboard for posting in public places.

A printed blotter urging co-operation in fire prevention for distribution among merchants, bankers and others.

A puzzle drinking cup for folding, each side containing lines of suggestions in planting trees, caring for the farm woodlot, urging forest fire prevention and giving data on Texas forest resources, has been given wide distribution at the State Fair and among the school children of the State.

A manuscript is now in the press which contains the results of a survey of the State's forest resources, with detailed figures on standing

timber and out put of forest products for each of the forty eastern counties and a study of mesquite in twelve southwestern counties.

The newspapers and the lumber and farm journals have been most friendly in offering the use of their pages for the publication of forestry matters. The Forestry Department has hardly begun as yet to take full advantage of this opportunity owing to the pressure of other work. As time goes on, it is the aim to use the newspapers and journals far more freely in order to extend a knowledge of forestry among the people of Texas.

The State Forester has been called upon for numerous addresses before conventions and meetings of lumbermen, farmers and stock raisers, county and city organizations, Women's Clubs and Teacher's Institutes. More than 25 lectures on Forestry have been delivered during the year.

The preparation of exhibits for fairs offers an important means of reaching the public in an educational way. Material suitable for exhibits cannot be accumulated in a short space of time since specimens must be collected from all parts of the State, photographs and models made, samples of products of various wood using industries assembled and data compiled for use in diagrams and charts. The State Forester was able, however, to prepare an exhibit occupying nearly 1500 square feet of space for the State Fair at Dallas during the present fall. The cost of shipment, installation and supervision of a large exhibit makes it impossible to present an exhibit at various fairs until a larger appropriation is secured. In a number of States, the State Forestry Departments have small buildings usually constructed of logs, located permanently on their State Fair grounds where forestry exhibits may be shown from year to year. This suggestion is one which the State Forester hopes to see carried out in Texas.

During the year the State Forester has written approximately 1500 letters in answer to inquiries and in connection with the business of the Department, not counting administrative letters or circular letters which have from time to time been addressed to county officials, demonstration agents and others in securing information concerning State conditions. During the first half of the fiscal year a stenographer was employed to handle the clerical work but during the latter half a trained Forestry Assistant was secured who has been able to do the stenographic work and devote the balance of his time to technical lines. The increasing amount of letter writing and clerical work will soon necessitate the employment of a stenographer under full time and permit the assistant to work solely along investigative lines and in teaching.

Forestry Investigations Under the State Experiment Station.

The State Forester is in charge of a Division of Forestry of the Texas Experiment Station. The work carried on under this Division is of course entirely experimental. On October 1, 1915, the Director of the Station approved a project entitled "Introduction and Propagation of Forest and Shade Trees in Different Regions of Texas." The object of this study is to determine which native American and foreign trees are most suitable

to introduce into the widely varying soil and climatic conditions of Texas for fence posts, shelterbelts, fuel supply and shade and under what methods of pruning, spacing and general nursery and planting practice the best results in growth, form and vigor may be secured.

The work is being done on the various sub-Station farms over the State. In starting the work, from 25 to 50 one year old seeding trees of each of thirty-eight different species were purchased from nursery dealers and set out in nursery rows on the sub-Stations at Troup, Temple, Lubbock, Nacogdoches and College Station. This was done in order that stock suitable for permanent planting might be secured in advance of the time necessary to grow it from seed. In the early spring of 1916 seed beds were prepared at the Troup sub-Station and 30 additional species were grown from seed. Before the next growing season the one year old seedlings from the seed beds will be transplanted to nursery rows to remain an additional year or more before being permanently planted. The final planting of the various species grown from seed and purchased will be done on or near the different Experiment Station farms. A system of printed blank forms has been devised so that observations on the seed bed, nursery and final planting work may be made and recorded separately and in great detail. Each year additional species will be grown from seed so that eventually a large number of species grown and planted in different ways under widely varying soil and climatic conditions will be recorded and furnish a basis for published reports by the State Experiment Station.

The organization of the State Experiment Station with its twelve or more scattered experiment farms, each in charge of a trained superintendent, is ideal for the carrying out of this tree planting project. The detailed work is carefully conducted. Permanent plantings will be wisely made and even where done outside of Station lands, the same careful records will be maintained. It is planned to establish plantations on private or public lands adjacent to Station farms wherever a willingness to co-operate is shown on the part of individuals. The value of the experimental data obtained in the course of a few years will be very great. Species of trees from other parts of the United States and abroad will undoubtedly be found which are adaptable to one section or another of Texas. The best methods of conducting nursery work, transplanting, pruning and caring for trees after planting will be ascertained and the information made available to all persons interested in tree planting. There is no limit to the possible expansion of this work or to the results which may be secured. There are difficulties in the way of successful tree growing in many parts of Texas which cannot be solved without experimentation. That many desirable trees can be grown even under the most difficult and perplexing conditions is without question.

Forestry at the Agricultural and Mechanical College.

A Department of Forestry at the Agricultural and Mechanical College was created by virtue of the Forestry Act of 1915 and the State Forester was made the Professor of Forestry at the College. In view of organizing

the State and Experiment Station work in forestry it was found inexpedient for the State Forester to conduct any forestry courses during the college year 1915-16. A series of lectures, however, was given to the horticultural and other students during the fall. For the College year 1916-17 six elective courses on forestry subjects were listed in the College catalogue, four open to seniors and juniors in agriculture and two for short course students in agriculture. The comparatively large number of students registering for the first term courses makes it probable that the teaching of forestry will become an important part of the State Forester's duties. Other courses will from time to time be added to the curriculum and as the teaching work increases, in order not to restrict the activities along State and Experiment Station lines, additions to the force will be absolutely necessary.

The question of offering a four year course leading to the degree of Bachelor of Science in Forestry has already arisen. In the judgement of the State Forester this should not be done at present but as a demand for graduates trained in forestry becomes apparent in the State a four year course may well be offered. The greatest need at present is to encourage men who are to graduate in agriculture to elect sufficient forestry work during their course so that they may better manage the woodlands on their home farms, spread a knowledge of forestry in the schools they teach and bring about a better understanding of the principles of caring for trees and forests in the communities where they live.

PLANS FOR IMPROVING THE WORK IN FORESTRY.

1. Fire Prevention in Cooperation with the Government.

Approximately 7,500,000 acres are under patrol during a period of four months from September 1 to December 31. There are approximately 16,500,000 acres in Eastern Texas where the influence of this patrol work is desirable, 9,000,000 acres of which are not being patrolled at present. There is need to more than double the patrol area another year and in addition patrolmen should be employed not alone for four months in the fall but also during two months in the spring before the vegetation becomes sufficiently green to prevent the spread of fires. The present co-operative agreement with the Government limits the Federal expenditures to twenty-five hundred (\$2500) dollars this calendar year. It may be increased, however, up to a limit of ten thousand (\$10,000) dollars if the State provides the money to offset the Federal allotment. In order to double the amount of patrol work, which is urgently needed, the State expenditures for each of the next two years should be increased from twenty-five hundred (\$2500) dollars to five thousand (\$5,000.00) dollars a year so that an equal amount may be obtained from the Government. By so doing the greater part of the East Texas Timber Belt may be brought under a system of patrol in an educational way.

The Forestry Act should be amended so that agents and patrolmen appointed by the State Forester may possess and exercise the authority and power held by constables at common law thus enabling them to arrest and prosecute persons violating the forest laws of the State.

2. Tree Planting in Texas.

Interest in tree planting in West and Central Texas and the lack of suitable trees to plant warrant the employment of a technical planting assistant with headquarters in Western Texas and the establishment of one or more State nurseries where planting stock may be grown and distributed at cost to persons who desire it. While the State Forestry law unquestionably authorizes the State Forester to establish and maintain nurseries for growing trees there may be some question as to the advisability of entering into a commercial distribution of trees without specific authority from the Legislature. It would be desirable to amend the Forestry Act, authorizing the State Forester to establish such State nurseries and to sell trees at cost.

The time is approaching when some provision should be made by the State to prevent unnecessary and wanton injury to roadside trees and to encourage roadside planting on a large scale. A number of States have roadside tree laws, notably California, New Jersey, Maryland and Pennsylvania. Some provide for the election or appointment of county or township tree wardens. In California county boards of forestry may be appointed by the county supervisors to have charge and control of all shade trees growing upon the public highways. In Maryland permission to remove or trim roadside trees must be secured from the State Board of Forestry. Forest wardens and other police officials are responsible for the enforcement of the law. In New Jersey, Pennsylvania and other States the law provides for the appointment of tree commissioners at the option of the various municipalities of the State to have charge of the trees and control tree planting along highways. In all these States it is a misdemeanor punishable by a fine to injure or remove trees along public highways without authority. Trees for planting along roadsides in some States are grown in the State forest nurseries and sold at cost. In Texas considerable thought is being given to the preservation of existing roadside trees. The importance of a law to prevent unnecessary injury is becoming apparent.

By statutory enactment Arbor Day in Texas comes on Washington's Birthday, February 22. Over most of the State this date is too late for the most effective results in tree planting, particularly in seasons where the early spring months are noticeably dry. By placing the official tree planting date earlier in the winter or in the late fall the young trees would receive the benefit of winter rains before the growing season commences. In addition whatever interest in Arbor Day planting is evidenced by the general public would have a better chance to materialize if the date were toward the beginning rather than at the end of the season for the most successful planting.

3. Farm Woodlot Demonstration.

The management of woodlots in connection with farms throughout Central and Eastern Texas offers a large field for expert forestry work. The woodlot should be given proportionate consideration on every farm. Nearly every county, except in the western part of the State, contains from

five to twenty per cent, or more, of woodland and these woodlands, except where large timber holdings exist in Eastern Texas, are attached to farms. Owners are receiving an increasing revenue each year from their woodlands. The value of all firewood, fencing, logs, railroad ties, telegraph and telephone poles, barrel staves and other forest products used on the farms or sold from farms in Texas in 1899 amounted to \$3,520,033. In 1909 this value had increased to \$8,925,662. This is an astonishing statement when it is realized that the figures represent forest products of farms and exclude products from timber holdings not attached to farms. The farm forests are in need of management in order that they may yield continuous revenues. Farmers should have a knowledge of the best markets for their woodlot products in order that they may secure better returns.

A ruling made by the States Relations Service of the United States Department of Agriculture, which has charge of the Federal expenditures under the Smith-Lever Law, now permits the use of Federal funds for demonstration work on farm woodlots. It is possible under this ruling to secure part of the funds necessary to employ a farm woodlot demonstrator from the States Relations Service. Since the Texas Forestry Act of 1915 provides (Section 1) that the State Forester shall, under the general supervision of the Board of Directors, have direction of all forest interests and all matters pertaining to forestry within the jurisdiction of the State, it is desirable that part of the salary and expenses of the woodlot demonstration agent be paid from State Forestry funds, with the expectation that the balance will be furnished either entirely by the States Relations Service or by the States Relation Service and our State Extension Service jointly.

4. Educational Work.

With increased funds and facilities at the disposal of the State Forester it will be possible to carry on numerous lines of educational work in forestry. This will consist of frequent published articles in the newspapers and journals, public addresses, assistance to public school teachers and the school children of the State, exhibits at numerous fairs, publication of bulletins and leaflets for general distribution and general correspondence.

The courses in forestry offered to agricultural students at the Agricultural and Mechanical College will become more important from year to year. It should be possible also to give series of lectures at other educational institutions within the State from time to time.

5. Investigative Work.

The project "Introduction and Propagation of Forest and Shade Trees in Different Regions of Texas" under the State Experiment Station is already well under way on various sub-Station farms. This work will be continued and each sub-Station will eventually be supplied with planting stock or grow its own stock for permanent planting. It will be the aim to determine the best species of trees for varying localities within the State and the best methods of propagating them under adverse natural conditions. New projects are under consideration and will soon be presented to the Station Director for approval. One is the effect of fire and grazing on

the soil, humus and reproduction; another contemplated project is the use of woods, treated and untreated, for fence posts.

Examinations of forest conditions and resources will be continued so that reliable information regarding the forests of every section and county will ultimately be secured. Detailed regional or county studies will replace general studies made during the first year. A study of markets in connection with the sale of minor woodlot products will help to aid farmers and others not acquainted with the best means of disposing of their forest products. There are a number of special studies which should be made in the near future, perhaps the most important of which is a study of the cedar industry in Central Texas.

6. Co-operation in Preparing Working Plans.

It is the aim to make the State Forestry Department of service to all the people of the State. Co-operation with cities, corporations, public and private institutions and individuals will be encouraged as rapidly as means are available for doing the work.

7. State and National Forests in Texas.

Section 3 of the Forestry Act of 1915 authorizes the Board of Directors to accept gifts of land and to purchase lands to be held, protected and administered as State forests. Public spirit has not as yet been sufficiently aroused among private owners to lead them to turn over any part of their holdings to the State. Many owners of cut-over timberland in East Texas could leave no better monument than a tract of land as a State forest. There is abundant prospect that gifts will be made in the future when private interests realize that State forestry in Texas has become an established and permanent issue.

As soon as funds are available, small areas in a number of different sections of the State should be purchased as demonstration forests to show what may be accomplished through planting, reproducing and improving the forests on lands of little agricultural value. Many States are purchasing large tracts as State forests. Several have already acquired more than a million acres each for the protection of tributary streams and to grow timber for the future. This may prove to be desirable in Texas but at present the State forest policies which Texas should strive to emulate are those which provide for purchasing small, more or less widely scattered tracts for purposes of demonstration.

The Federal Government under the Weeks Law is engaged in the purchase of non-agricultural forest lands in the Southern Appalachian Mountain States and in New Hampshire as National forests to protect the headwaters of navigable streams. So far purchases have only been made in the above regions and of course only where the States have passed enabling acts, authorizing the Federal Government to make these purchases for the purpose named. While there is no immediate likelihood that the Government will enter new regions for purposes of purchase under the Weeks Law these purchases may be made in any State which has given its sanction. It would be desirable for the next Legislature to pass such an enabling act as expressing to Congress approval of this work and in order that National forests may sometime be established in Texas.

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FOREST RESOURCES OF EASTERN TEXAS

BY

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FOREST RESOURCES OF EASTERN TEXAS.

INTRODUCTION.

During the past year the State Forester's office has been engaged in studying the forest resources, the industries dependent upon the forest, and the outputs of the forest products in forty of the eastern counties of Texas. These counties, with an area of nearly 21,000,000 acres, and commonly known as the "East Texas Timber Belt," contribute most of the manufactured lumber, as well as the bulk of other forest products, which in the aggregate place Texas among the leading States of the country in annual timber production. A number of other adjacent counties, however, might properly be considered a part of the main timber belt of East Texas. The county examinations were made in conjunction with the work of forest fire prevention in East Texas. An effort was made to meet as many operators and county officials as possible and secure information from the most reliable sources in each county. Lack of time prevented exhaustive and detailed studies of these counties, but the State Forester plans to carry on complete studies of forest conditions, county by county, as soon as funds are available for such work.



Map 1.—Counties Included in Study of Forest Resources of Eastern Texas.
Area within: 1—Longleaf pine region. 2—Shortleaf pine region.
3—Loblolly pine region. 4—Post oak area.

Map 1, which accompanies this report, indicates in the shaded area the location of the forty counties examined and should be useful in connection with the reading of the county descriptions. The division into four forest regions conforms to a general division of the State into forest regions or belts (see Bulletin 3, Department of Forestry, College Station, Texas, entitled "General Survey of Texas Woodlands"). The pine regions, including the longleaf, shortleaf, and loblolly, have been for many years, and still are, the chief sources of lumber and other forest products in Texas. The southern boundary of the loblolly pine region marks the transition from timberland to the open, grass prairies of the eastern Gulf Coast. The line between the shortleaf pine and the post oak regions shows, for the northern section only, the transition from the heavier pine and hardwood forests of the East Texas Timber Belt to the scrubby, mixed hardwood forests of East-Central Texas. Through all these forest regions there are bottom lands which contain hardwood species of great variety and value, much of which still remains to be cut. The swamps and bayous which overflow throughout the year and contain cypress and tupelo are not of great extent in Texas. They are located mostly in the eastern and southern portions of the loblolly pine region.

Essentially an agricultural region, the manufacture of forest products in East Texas is so important as to rank third among all manufacturing industries of Texas. Not less than 25,000 persons find employment in the forest industries. Over large portions of the East Texas Timber Belt lumbering has reached its zenith and declined. In other portions it is now at its height and overshadows all other industries. At the present time one-third of the total area consists of culled and cut-over timberlands, nearly one-third is improved agricultural land, while the balance is made up of virgin and second growth forest, pasture, waste, and overflowed lands.

CLASSIFICATION OF LANDS.

A summary of the land classifications of the forty counties is as follows:

Class of land.	Acres.	Per cent of total area.
Virgin timber	2,916,000	14.1
Second growth	1,720,000	8.3
Culled and cut-over.....	7,758,000	37.4
All other lands.....	8,332,340	40.2
Total	20,726,340	100.0

Virgin timber lands represent the areas where logging has not as yet taken place. Records were available only for the larger and more compact bodies of such timber. Scattered areas of small size could not be determined. Map 2 shows in a general way the areas within which the larger bodies of virgin timber, mostly yellow pine, are located in the counties examined.

Second growth lands are intended to represent those which have restocked to a more or less merchantable stand, either from old fields or from lands long ago logged, but where the trees in the original stand do not to any great extent constitute the present stand per acre.

Culled and cut-over lands are those logged either long ago or recently and where the merchantable material consists of trees which were in the original stand and left from former logging operations. Reproduction and young unmerchantable growth may or may not be present.

All other lands consist of improved and unimproved areas which are not timbered. Approximately 73 per cent of the area in this class is improved land within farms, while the balance consists of pasture, waste, and overflow lands. The area of improved lands in the region covered has increased 20.8 per cent since the census of 1910, according to the



Map 2.—Areas Within Which the Main Bodies of Virgin Timber (Mostly Yellow Pine) Are Located.
(Dots indicate approximate locations of sawmills cutting 10 million feet or more annually.)

figures obtained in each county. The increase from 1900 to 1910, according to the census, was 22.7 per cent.

Assuming for purposes of computation that virgin timber lands average 9,000 board feet per acre, second growth lands average 1,500 feet, and culled and cut-over lands average 3,500 feet, the total standing timber in the forty East Texas counties would be about 56 billion board feet. In 1911 the Government* estimated the standing timber in the forty-eight most eastern counties to be 66 billion feet. About ten billion feet of timber have been cut since the Government investigation was made, as against

*The Lumber Industry—Part I—Bureau of Corporations, U. S. Department of Commerce and Labor, Washington, D. C., 1913.

perhaps one and one-half billion feet of new growth formed since that time. Eight additional counties, chiefly hardwood counties, were also included in the Government's estimate. While the two sets of figures do not cover exactly the same areas and the arbitrary yields per acre may be either high or low, nevertheless, having been reached by entirely different means, they furnish a basis for reasonably accurate conclusions as to the amount of standing timber in eastern Texas.

FOREST PRODUCTS OF EASTERN TEXAS.

The greater part of the products from East Texas forests is in the form of lumber, laths, and shingles. There are approximately 345 sawmills in the 40 counties examined, 66 of which have an annual capacity of at least 10,000,000 feet of lumber each. The approximate locations of these large mills are shown by dots on Map 2. The balance of the sawmills varies in annual cut down to as low as a few hundred thousand feet each. The number of small portable, or semi-portable, mills and combination mills is increasing, the greater number being operated in sections abandoned by the large mills. The total annual output of lumber, determined by the survey of the 40 counties, is 1,685,000,000 board feet. Doubtless this includes a large quantity of laths and shingles and perhaps railroad ties. Jasper County leads in the cut of lumber, producing no less than 300,000,000 feet annually. Polk and San Augustine follow with 150,000,000 feet each.

The total number of railroad ties, both sawed and hewn, of which a record could be obtained is 2,399,000. Although the ties sawed in the larger mills could not be separated or checked, it is probable that most of the ties produced are hewn in the woods and sold along the railroad. Out of 40 counties at least 30 produce ties in abundance. The largest tie producing section is in the loblolly pine belt, of which Montgomery County is perhaps the center. A large part of the ties produced are sent to creosoting plants for preservative treatment before being placed in service.

The stave industry in Texas is falling off owing to the rapid decrease in the supply of white oak, the chief stave wood. Eleven counties produce 873,000 staves which represents the bulk of the output. Panola County leads with an annual output of 300,000 staves. One large stave manufacturing plant in Texarkana draws upon the entire surrounding region, even outside of the State, for its raw material. One heading mill reports the use of 216 cords of wood monthly.

Mine props aggregating 100,500 are produced in six counties and shipped to mining sections in Texas and outside of the State. This is a comparatively small industry but one which appears to be growing in importance. Yellow pine is the chief wood used for props.

Fence posts represent one of the most important products for local consumption. Locally posts are used on every farm and sold in every town. Fence posts are not extensively shipped from the region although five counties produced 168,000 posts for shipment.

Telephone and telegraph poles are shipped from a number of counties, notably Tyler, Hardin, Trinity, and Bowie, and are used locally in other counties. The reported shipments amount to 57,700 poles annually.

Piling to the extent of 17,700 pieces is shipped from four southern counties.

Fuelwood, like fence posts, is used far more extensively for home consumption than for export. However, 23 counties ship 177,650 cords of wood either to cities within the region or to other parts of the State. The amount of home consumption cannot easily be determined although the average home probably uses eight to ten cords annually.

Charcoal is not an important product of East Texas. The only shipments recorded were 153 tons from the southern counties.

Shingles are manufactured not only in the large sawmills from slabs and trimmings but also in numerous small shingle mills scattered over eastern Texas. Not less than 6,500,000 shingles are produced in the small plants.

Turpentine is not extensive in Texas as compared with some other southern States within the longleaf pine belt. The area at present devoted to the turpentine industry consists of 289,300 acres in Tyler, Polk, Jasper, Newton, San Jacinto, Sabine, and Hardin counties. Among these Polk County leads with 160,000 acres.

In addition to the above there are numerous other industries which use limited quantities of wood. The box and crate industry is represented by about 14 mills, most of which are in the northeastern counties. Five of these mills consume approximately 10,600,000 board feet of gum annually. There are six handle factories and two mattress factories which use small quantities of cordwood. There is a great opportunity to increase and build up these small industries in sections where lumbering on a large scale has ceased to be an important industry.

FOREST RESOURCES, INDUSTRIES AND OUTPUTS BY COUNTIES.

ANDERSON COUNTY.

The eastern portion, not more than one-fourth of the county, lies within the shortleaf pine region, the remainder being in the post oak region. The broken and hilly land surface drains into the Neches and Trinity Rivers. Soils range from light sands to heavy, dark loams, a large part of the total area being in the red land belt. Several scattered areas of sandstone are found in the county. Public roads for the most part show considerable improvement. More than 59 miles of mainline but no logging railroads serve the county.

The land area may be divided as follows:

Approximate total area.....	678,400 acres.
Virgin timber lands.....	50,000 acres.
Second growth lands.....	238,000 acres.
Culled and cut-over lands.....	15,000 acres.
All other lands.....	375,400 acres.

The virgin timber lands lie chiefly along the eastern boundary of the county and support a growth of pine and mixed hardwoods. More than 30,000 acres of this class are shortleaf pine. A large acreage of oak and mixed hardwoods occupies the bottomlands along the Neches River.

The timber is held in large tracts by the lumber companies. Timber deeds reserve the land but often allow 20 years in which to remove the timber. Very little cutting is being done at present.

Second growth lands, as considered in this county, are those of the post oak type. The tree growth consists mainly of post and black jack oaks and sweet gum of decidedly poor quality and size. At the present time the major portion of this timber is not merchantable except for fuel where it is easily accessible.

Culled and cut-over lands have been cut within the past 10 years. These lands were culled lightly but practically all the resultant timber will be black jack and post oaks and gum.

Considerable progress is being made in intensive farming and although not much new land is being cleared annually, no old lands are being abandoned. Farms range in size from 10 to 1,000 acres, by far the greater proportion being small ones. Farm lands if not properly handled are subject to severe erosion. More than 150,000 acres of prairie land are found in the county. This area is used for grazing and tree growth is practically absent. A comparatively small portion of the total area of the county may be classed as eroded, overflow and swamp lands. Nearly all the county is under hog law.

No very large mills have ever been operated in Anderson County, although a number of smaller mills have cut irregularly for about 25 years. Twelve mills, one with a capacity of 40 thousand feet daily, the remainder small and irregular in their cut, are operating at this time with a total output of approximately 8,000,000 board feet annually. At this rate they may continue indefinitely.

Two portable tie mills cut 60 per cent of the total yearly output of 65,000 ties; 75 per cent oak, 25 per cent gum. Nearly 8,000 cords of fuelwood are said to be shipped annually, the producer receiving on an average about \$2 per cord at the railroad. The fence post production is governed entirely by the local demand; it is estimated that probably 3,000 split posts are disposed of annually in Palestine. Although there are two box and crate factories in the county only one is being operated this year.

Grass and woodland fires are started in Anderson County under the belief that burning prevents the spread of underbrush. The fallacy of this belief, however, is amply demonstrated by the presence of large areas of heavy underbrush and the absence of reproduction of more desirable species on burned-over areas.

ANGELINA COUNTY.

Approximately 20 per cent of the total area of Angelina County, the northern portion, lies within the shortleaf pine region while the remaining 80 per cent is located in the longleaf region. The generally level land surface drains to the southeast and southwest into the Angelina and Neches Rivers, respectively. Soils vary from light loams to heavier loams and clays and in the main are very fertile when properly cultivated. Public roads are being slowly improved. One hundred and fifty-nine miles of mainline and not more than 15 miles of logging railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	563,200 acres.
Virgin timber lands.....	60,000 acres.
Second growth lands.....	60,000 acres.
Culled and cut-over lands.....	300,000 acres.
All other lands.....	143,200 acres.

Virgin timber stands are composed mainly of longleaf pine with some mixed hardwoods along the streams and in the bottom lands. Timber and land are usually under the same ownership and for the most part are held in large tracts by the lumber companies.

Second growth stands are mainly in small tracts scattered over the county. A small acreage is from abandoned old fields. Judged by the nearby counties there is a decided tendency to recognize the future value of this class of timber.

The culled and cut-over woodland areas show an almost total lack of longleaf pine reproduction although some shortleaf pine and abundant young growth of the various hardwoods, particularly red oak, is found. This condition is doubtless due to the frequent occurrence of grass and woodland fires. Soils over much of this type are suitable for agriculture and will be so used in time.

Agricultural operations are rapidly extending. Within the past two years the average of improved farm lands has increased at least 25 per cent. There are no abandoned farm lands. Farms range in size from 20 to 200 acres although one farm in the county embraces 400 acres. Farm lands are in an excellent state of cultivation and show but little serious erosion. No part of the county is under stock law, except the city limits of Lufkin.

The lumber industry has been an important one in Angelina County for the past 25 or 30 years. Eleven mills, one 300 thousand, one 200 thousand, two 100 thousand, one 65 thousand, two 35 thousand and one 30 thousand feet daily capacity, the remainder comparatively small, produce approximately 65,000,000 board feet annually. One of the 100 thousand-foot mills trams its raw material from Nacogdoches County. Two mills in the county are cutting hardwoods exclusively, but it is estimated their total cut will not exceed 100,000 feet annually. In view of the fact that large timber holdings are as yet untouched the lumber industry may be expected to continue indefinitely. The large mills now in operation will continue for five or six years at their present rate of production.

At the present time there are no turpentine operators in the county. Tie operators produce 40,000 pine, 15,000 red oak and 10,000 white oak ties annually, the greater proportion of which are hewn. This industry may last indefinitely. Owing to the scarcity of suitable raw material the stave production amounts to only 5,000 staves per year and is about finished. The consumption of fuelwood approximates 10,000 cords yearly and will continue indefinitely. Perhaps 2,500 telegraph and telephone poles are cut each year. One factory at Lufkin is engaged in the manufacture of excelsior mattresses and consumes about 100 cords of pine cordwood annually. One veneer plant, capacity 12 thousand feet per day, has recently started operations at Lufkin.

The greater number of fires are started by tram engines, the county burning over about once in four years. The standard lines of railroad use oil for fuel. Fires also appear to be started in order to eliminate insect pests and not to improve the grazing as is so frequently the case. A second growth of desirable timber cannot be grown unless burning is restricted.

BOWIE COUNTY.

Bowie County, located in the extreme northeastern corner of the State, lies entirely within the shortleaf pine region. The generally level to slightly rolling land surface drains into the Red and Sulphur Rivers, which form the northern and southern boundaries of the county. Soils vary from a light colored loam to a dark loam underlaid by clay in the bottoms and along the streams. Public roads show much improvement; practically all of them are graded and several miles are surfaced. Sulphur Fork and Red River are both navigable to some extent. More than 108 miles of mainline but no logging railroads are operated in the county.

The land area may be divided as follows:

Approximate total area.....	578,560 acres.
Virgin timber lands.....	35,000 acres.
Second growth lands.....	45,000 acres.
Culled and cut-over lands.....	320,000 acres.
All other lands.....	178,560 acres.

Virgin timber lands support a growth of mixed hardwoods and shortleaf pine. The hardwoods occupy the better situations along the streams in the northern and southern sections of the county. Stumpage values range from \$1.50 to \$5 per thousand. Pine is found on the poorer lands and becomes scarcer as one goes from east to west across the county. It is estimated that all the virgin pine will be cut out in another year. Virgin timber is owned by mill companies and local residents.

Second growth lands are scattered over the county and for the most part are timbered with pine although some hardwood, noticeably post oak, is found. Stands of timber in this type are mainly from old fields. The timber is little damaged by fire owing to the relatively advanced age of the stands.

Culled and cut-over lands dating back 10 or 15 years are being slowly reforested with a growth of mixed hardwoods and pine. The hardwoods now form the greater percentage of the volume per acre. Such of these lands as were not cut clear years ago will furnish timber for a second cut within a few years. Most lands in this type are agricultural lands and will be so used at some future time.

Although Bowie County is located in the East Texas timber belt agriculture takes precedence over the lumbering industry. Improved farm lands have a comparatively high valuation. The timber from clearing is worked into ties and if accessible to the railroad is shipped as fuelwood. Farms range from 100 to 200 acres in size. Improved farm lands are but little subject to erosion because of the level topography. Practically the entire county is under hog law.

Overflow areas are found along both the Red and Sulphur Rivers and practically all streams in the county. Of this class approximately 30,000

acres are subject to yearly inundation while 90,000 to 100,000 acres additional are inundated at less frequent intervals. The greater part of the latter acreage is improved land.

Lumbering dates back 30 to 35 years in Bowie County and on a large scale has disappeared. Five small sawmills are operating at the present time and produce not more than 5,000,000 feet annually. While the pine is practically exhausted, small hardwood operations may last many years.

No fuelwood is shipped from the county and not more than 1,000 cords are sold locally. The low consumption of fuelwood is due to the use of natural gas. Shortage of suitable timber prohibits the shipping of fence posts and the only traffic in this product is a small local one. Telegraph poles to the number of 15,000 are cut annually. The stave industry using timber from Bowie County alone is a small one, although one large stave plant located at Texarkana draws upon the surrounding territory, even outside of the State, for its raw material. Tie cutting operations are on a fairly large scale due to the prevalence of hardwood timber; 200,000 hewn oak ties with a value of \$54,000 are cut annually. At this rate, however, the industry cannot continue for many years because of the general lack of reproduction on the earlier cut-over areas. Two small shingle mills produce not more than 160,000 shingles per year. A number of furniture, mattress, casket and other wood-using industries are located in Bowie County. Two creosoting plants specialize in the preservative treatment of timber.

Uncontrolled burning is not a serious problem in this county because of the comparatively large acreage of cleared and improved farm land and overflowed land. Notwithstanding this fact reforestation of cut-over areas is slow and shortleaf pine reproduction is noticeably absent. Heavy cuttings which left an insufficient number of seed trees are responsible for this condition. Clear cutting methods should only be practiced on such lands as are to be utilized for agricultural purposes.

CAMP COUNTY.

Camp County lies entirely within the shortleaf pine region although the western boundary of the county practically coincides with the western limit of commercial shortleaf timber. The land surface is rolling and drains to the south and east into Big Cypress River. Several small areas of sandstone are found in the county, but no rock formations of any importance. Soils are light loams with red clay subsoils. Public roads are gradually being improved and at least one road district has issued bonds to carry on the work. Not more than 28 miles of mainline railroad are located in the county.

The land area may be divided as follows:

Approximate total area.....	138,880 acres.
Virgin timber lands.....	5,000 acres.
Second growth lands.....	5,000 acres.
Culled and cut-over lands.....	25,000 acres.
All other lands.....	103,880 acres.

Virgin timber stands consist of pine and mixed hardwoods, the latter type predominating. The greater percentage of lands in this class, however, supports a growth of unmerchantable timber which in size and quality is not comparable to virgin timber as commonly understood.

Second growth lands are mainly old fields in scattered tracts over the county. Pine in small quantities and mixed hardwoods compose the type. No importance is attached to the future value of this class of timber, although a large area will now cut from 300 to 1,000 board feet per acre.

Culled and cut-over lands date from 35 years ago to the present time. A large acreage in this type has been cut a second time and at present only a very small area supports merchantable timber. Lands cut over recently have not been clear cut, however, the limit being often fixed at eight inches in diameter and will consequently produce a second crop within a few years.

Diversified farming and fruit growing place agriculture in a prosperous condition. Farms range in size from 50 to 150 acres. Practically no old lands have been abandoned in recent years. Farm lands are but little subject to erosion. All of the county is under hog law and most of it under general stock law.

Lumbering operations have been conducted for 35 years. Two small mills are cutting very irregularly at the present time and produce not more than 5,000,000 feet annually. Even with this small production they are likely to cut out in the next two years because of scarcity of suitable timber. There are no tie or stave operators in the county. One shingle mill produces approximately 600,000 shingles annually. At this rate, however, the industry may last indefinitely as small pine timber may be utilized by the mills. One box and crate factory consumes not less than 600,000 board feet of gum annually.

The general sentiment in Camp County is decidedly against burning the grass and woodlands and fires seldom occur. As a consequence reproduction of the native tree species is abundant where conditions for natural seeding are good.

CASS COUNTY.

Cass County lies entirely within the shortleaf pine region. The land surface, broken and hilly in the west to level or slightly rolling in the east, drains to the east and southeast into the Sulphur and Big Cypress Rivers, respectively. Soils are sandy loams with a clay subsoil. Scattered iron ore deposits are found in the western portion of the county. Although there is no bond issue for the purpose public roads are being generally improved. About 95 miles of mainline and 18 miles of logging railroad furnish good transportation facilities.

The land area may be divided as follows:

Approximate total area.....	604,800 acres.
Virgin timber lands.....	10,000 acres.
Second growth lands.....	90,000 acres.
Culled and cut-over lands.....	294,000 acres.
All other lands.....	210,800 acres.

Practically all the virgin timber is mixed hardwoods along the Sulphur River. Areas lying in the northwestern section of the county are owned almost exclusively by the larger lumber companies. In cutting virgin timber no diameter limit is set and stands are practically cut clean.

Second growth areas are mainly from old fields and are located in scattered tracts throughout the county. There are no merchantable second growth stands which have originated from cut-over lands. Very little importance is placed upon the future value of the timber.

Areas cut over within 15 years have been practically denuded of their timber. Older cuttings have resulted in much shortleaf pine reproduction, but the timber will hardly be merchantable for many years. Lands in this class are for the most part adapted to agriculture, but such use is far in the future.



Timber Cutting is Accompanied by Great Waste through High Stumps and Unused Slabs and Tops.

Home owners practice diversified farming, while renters grow the staples, such as cotton and corn. Some new land is being cleared annually, although many farms abandoned at the close of the Civil War have never been put back into cultivation. Farms average 80 to 200 acres in size. Considerable progress has been made in farm management during the past five years as the lumber industry is not large enough to interfere with agricultural development. Farm lands in the more hilly sections are subject to severe washing and much terracing is done in all sections of the county. Three-fourths of the county is under hog law and one or two districts have general stock law.

Lumbering operations date back 35 years. Eight mills, one of 45

thousand feet or more daily capacity, the remainder being small local ones, produce not more than 40,000,000 feet of lumber annually. At this rate these mills, particularly the larger ones, will cut out in about two years.

Not more than 30,000 hewn shortleaf pine ties are produced annually. Waste characterizes the cutting operations and the industry may not last longer than five or six years. The fuelwood and fence post production depends upon the local demand and is practically negligible. One shingle mill, one chair and one handle factory are operating in the county, but run very irregularly. In view of the quantity of merchantable hardwood along the Sulphur River these industries may continue indefinitely at their present rate of production and new mills will undoubtedly be established.

While general public sentiment is against burning the grass and woodlands in Cass County, there yet exists a serious fire problem. Fires are started by careless or malicious persons as well as by logging engines. Approximately 50 per cent or more of the total area burns over annually. Where burning is restricted and the woodlands protected, shortleaf pine is reforesting the earlier cut-over lands.

CHEROKEE COUNTY.

Cherokee County lies entirely within the shortleaf pine region. The land surface, broken and hilly in the north, but rolling in the south, drains to the southeast through the Neches and Angelina Rivers. Iron ore deposits are found throughout the county, the most valuable being in the northern portion. Soils vary from light sand to red or chocolate colored loams and in the main are very productive. All public roads are undergoing improvement. Not more than 122 miles of mainline and 25 miles of logging railroad are operated in the county.

The land area may be divided as follows:

Approximate total area.....	633,600 acres.
Virgin timber lands.....	155,000 acres.
Second growth lands.....	25,000 acres.
Culled and cut-over lands.....	220,000 acres.
All other lands.....	233,600 acres.

Of the virgin timber lands not more than 40 per cent are pine, the remainder being a mixed, scrubby and more or less unmerchantable growth of hardwoods. The best bodies of virgin timber are located in the southern portion of the county and are held in large tracts by lumber companies.

Second growth stands occupy a comparatively small area and the pine in this class is almost without exception of old field origin. Abandoned lands return very rapidly to old field pine.

Culled and cut-over lands, dating back 10 to 20 years or more, were culled lightly and now support a comparatively heavy growth of mixed hardwoods and shortleaf pine. Recently cut-over areas are restocking with gum, oak and some pine. Pine is scarce in the mixture because of fires and the greater relative proportion of hardwoods left after logging. A large percentage of this type of woodland is suitable for agriculture and will eventually be placed under cultivation. No effort is being made by lumber companies to sell their cut-over lands.

While truck farming has been the general trend of agricultural operations in the past there is now a decided tendency toward diversification. A small acreage of new land is being cleared annually. The tendency to abandon old lands has ceased. In clearing new land much timber is still burned, due to the lack of local markets. Farms average 20 to 200 acres in size. Only a small portion of the county area may be considered waste land. Erosion is probably the principal factor in causing lands to revert to this class, but conditions are rapidly improving, partly because these lands are being reclothed with forest growth. Approximately 90 per cent of the county is under hog law.

Lumbering operations date back about 20 years. Sixteen mills, two of large size and the remainder small and irregular in their cut, produce not more than 60,000,000 feet annually. Three years ago not less than 80 small mills were operating in Cherokee County, but the business depression of 1914 closed all the mills down. Those now cutting have resumed since that time. The larger mills will probably complete their cut within the next six or eight years, but the smaller ones may continue indefinitely because of the irregularity in their operations. There are no portable mills reported as operating in the county.

Not more than 25,000 hewn oak ties are cut annually. Since pine is not being used for ties the industry cannot enlarge until the railroads furnish a market for pine ties. Fuelwood and fence post production are governed solely by the local demand. The stave cut is negligible. One planing mill is supplied by the small sawmills and four box and crate factories are operating in the county.

Grass and woodland fires are usually caused by carelessness in clearing new land. Although the tram roads use wood for fuel, few fires from this cause are reported. Only a small portion of the county burns over annually and in consequence hardwoods and shortleaf pine are reproducing rapidly on many woodland areas.

FRANKLIN COUNTY.

About 20 per cent of the area of Franklin County, the extreme eastern portion, lies in the shortleaf region, the remainder being within the hardwood belt. The land surface is generally rolling to level and drains to the east through the Sulphur, White Oak and Big Cypress Rivers. Soils vary from light loams to heavy, black waxy. Streams in the county overflow at frequent intervals. There has been considerable improvement in public road conditions during the past five years. Not more than 15 miles of mainline and no logging railroads are located in the county.

The land area may be divided as follows:

Approximate total area.....	208,000 acres.
Virgin timber lands.....	Negligible.
Second growth lands.....	Negligible.
Culled and cut-over lands.....	65,000 acres.
All other lands.....	143,000 acres.

It might be said that practically all of the virgin timber has been cut out in Franklin County. The closeness of cutting has prohibited reproduction. Second growth areas are conspicuously absent.

Culled and cut-over lands comprise practically all of the timbered areas in the county. Probably the greater percentage of these lands, however, still supports a very light growth of merchantable timber. Practically all lands in this class are suitable for farming and the best of them will eventually be so used.

Diversified farming is practiced on improved lands. Farms are well kept and agricultural conditions are improving. Farms average 50 acres in size. In some sections lands are subject to severe washing. About half the county is under general stock law and about three-fourths under hog law.

Grass prairie lands, with practically no tree growth, cover an area of approximately 15,000 acres. Overflow lands total about 8,000 acres, but the larger part of this acreage can be drained and made suitable for agriculture.

Lumbering operations have been conducted in the county for more than 30 years, but never on a large scale. At the present time only one mill is cutting and produces approximately 3,000,000 feet annually. Practically the only other wood-using industry is one small shingle mill which operates very irregularly. The large area of the county under either general stock or hog law limits even the consumption of fence posts.

The practice of clear cutting timber lands prevents natural reforestation. On account of the well settled conditions, forest fires are infrequent. Franklin County should be a woodlot county with a small per cent of the area in well managed and productive farm forests. There is a good local market for fuel, posts, lumber and other products which should be grown at home.

GREGG COUNTY.

Gregg County lies entirely within the shortleaf pine region and is located approximately at the center of distribution of that species in East Texas. The greater portion of the rolling land surface drains to the southeast into the Sabine River which divides the county. Soils vary from light, loose, sandy loams to those of the compact, limy type. There is a small area of red soil in the southwest. Several small, irregular areas of sandstone are found in the northern portion of the county. Practically all the public roads have been graded and surfaced. More than 45 miles of mainline railroad traverse the county.

The land area may be divided as follows:

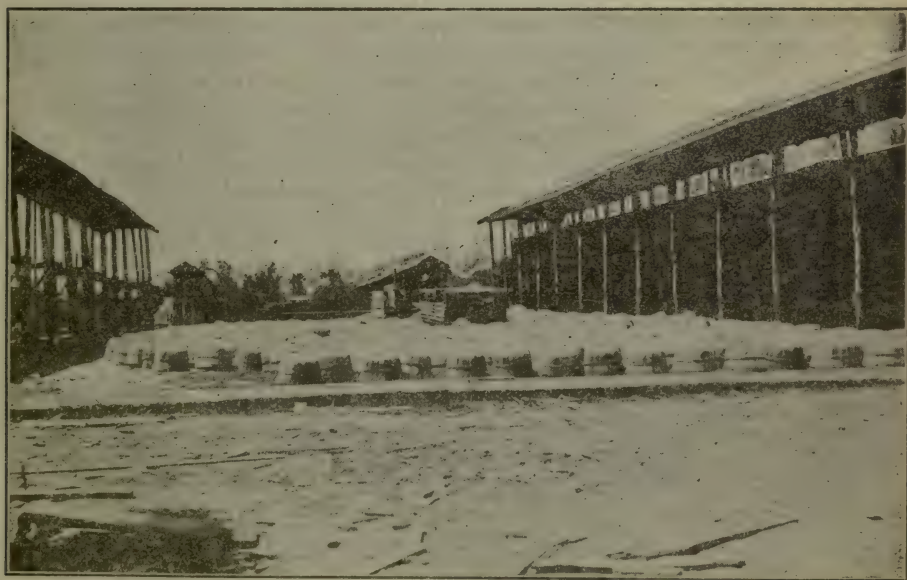
Approximate total area.....	183,680 acres.
Virgin timber lands.....	Negligible.
Second growth lands.....	50,000 acres.
Culled and cut-over lands.....	60,000 acres.
All other lands.....	73,680 acres.

With the exception of very small scattered stands of mixed hardwoods practically all of the virgin timber in Gregg County has been cut out.

Second growth lands support a stand of shortleaf pine and mixed hardwoods. The greater proportion of lands in this type consist of scattered tracts located for the most part in the southeastern portion of the county. Only a small acreage is from old fields. On practically all of



Type of Logs Used in East Texas Veneer Mills.



Drying Veneer Baskets Before Shipment.

these lands the timber has not reached merchantable size and is damaged annually by fires.

Culled and cut-over lands date back 43 years. Those cut at an early date are now being logged a second time. Present operations practically clear cut the areas. Most cut-over lands support a stand of shortleaf pine and mixed hardwoods and where fire is kept out will reproduce readily. These lands will eventually be sold for farms. A woodlot protected from fire and properly managed should be a part of each farm.

Diversified farming is the practice and agricultural conditions are improving each year. Although very little new land is cleared it is noticeable that no old land is abandoned. Farms average 100 acres in size. Soil washing is not a serious problem. Practically all the county is under hog law.

The lumbering industry dates back to 1873. Operations, formerly on a large scale, have decreased until at present six small mills with an irregular output produce approximately 10,000,000 feet annually. At this rate, however, they may operate indefinitely.

Tie operators produce in the neighborhood of 120,000 hewn ties annually, most of which are pine. All ties are treated before being used. The tie industry is exceedingly wasteful and cannot continue longer than six or seven years. One operator cuts more than 20,000 white oak staves annually and will probably continue to cut for four or five years. Cordwood production is governed entirely by the local demand. Telephone and telegraph poles are cut only for home consumption; the same may be said of fence posts. One factory at Longview consumes not less than 200 cords a year in the manufacture of excelsior mattresses. The supply of mine timber may last indefinitely at the present output of 15,000 mine props annually. Two shingle mills now operating are exceedingly irregular in their output. One box and crate factory consumes not more than 2,500,000 feet of gum yearly.

The timbered area of Gregg County burns over once every three to five years. Little attention is given to grass and woodland fires as long as farm improvements are not damaged. The regular occurrence of these fires, however, prevents the reforestation of cut-over lands with pine and encourages the growth of the less desirable of the hardwoods.

HARDIN COUNTY.

Hardin County is largely within the loblolly pine region, the north-eastern third being in the longleaf region. The land surface is flat or rolling and drains to the south and east into the Neches River. Much of the soil is sandy with a red clay subsoil, fine in texture and with a tendency to pack. A large area in the eastern portion of the county is composed of what is locally known as "crawfish" land. Practically all public roads in the county are graded and one road through the county is shelled. There are 116 miles of mainline and 95 miles of logging railroad in the county. Extensive oil interests are being developed in the section about Sour Lake.

The land area may be divided as follows:

Approximate total area.....	540,160 acres.
Virgin timber lands.....	125,000 acres.
Second growth lands.....	Negligible.
Culled and cut-over lands.....	350,000 acres.
All other lands.....	65,160 acres.

The area classified as virgin timber contains only about five per cent of longleaf pine lands and the same amount of cypress in two brakes, one east and the other west of Kountze. The balance, nearly 90 per cent, is in the well known "Big Thicket" of the southern part of the county and consists of mixed hardwoods more or less logged but still containing much valuable timber. The pine land as well as the timber is owned by the lumber operators.

As frequent and serious fires prevent reproduction the area of second growth lands is negligible and has been included in that of culled and cut-over lands. A striking example, however, of the results obtained when cut-over areas are protected is shown in a sapling stand of longleaf pine on the outskirts of Kountze. Trees from 15 to 25 years old are now six to eight inches in diameter, 35 to 40 feet tall and average about 1,200 trees to the acre.

Culled and cut-over lands dating back 10 to 25 years now support but little merchantable timber growth. Only a few stands in this class will average 300 to 1,000 feet per acre. In few sections of eastern Texas has clear cutting been more pronounced.

Farms in the county are small and the total improved land area is less than 7,000 acres. Some little new land is cleared annually and the timber burned during the process. Soil erosion is serious where lands are not protected. The prosperous farmer is one who combines stock raising with general farming. No part of the county is under stock law.

The livestock industry is one of the most important in Hardin County. Large numbers of cattle, sheep and goats are grazed on the cut-over lands and on an area of about 60,000 acres of prairie in the southern part of the county.

The lumbering industry began about 35 years ago. Seven mills, two cutting 100 thousand and 75 thousand feet, respectively, and the rest small and irregular in their cut, produce approximately 80,000,000 feet annually. One large sawmill at Voth, in Jefferson County, trams it raw material from Hardin County.

At present one turpentine operator is cropping the timber on approximately 8,000 acres. The cup and gutter system is used, timber being cut immediately following the cropping and the crop areas burned over annually. Approximately 7,500 pine, 2,000 red oak and 500 post oak hewn ties are cut yearly. Pine ties are treated before being used. Although waste characterizes the operation the tie industry may last indefinitely at this rate of production. The stave industry, formerly a large one, has decreased to a present annual output of not more than 3,000 white oak staves, but at this rate the industry may be expected to last indefinitely. Not more than ten cars of fuelwood are being shipped annually. There is, however, an abundance of cordwood in the county. In addition 5,000 telegraph poles, 12,000 pieces of railroad piling, 100,000 cubic feet of

squared timbers for export and a small amount of white hickory bolts for handles were shipped during the past year.

Most of Hardin County burns over annually. Fires are usually started by stockmen under the belief that grazing is improved and the custom meets with general approval. The cut-over lands, particularly those of the "crawfish" type, should be protected from fire in order that part at least may reproduce to timber. Present day logging methods, however, strip these lands while repeated burning and hog grazing further operate to keep out reproduction. A radical change in the method of handling cut-over lands in Hardin County is necessary if the growing of timber even on a small scale in this natural pine region is to be considered.

HARRIS COUNTY.

A line drawn east and west through the center of Harris County would mark the approximate southern limit of commercial loblolly pine. Very little pine is found west of Houston. The extremely low and level land surface drains to the southeast into Galveston Bay; better drainage conditions are a problem in certain sections of the county. Soils range from light sand to black waxy, a large percentage of the latter type being very fertile. Public roads are excellent, at least 400 miles being graded and paved. Approximately 386 miles of mainline railroad furnish excellent transportation facilities.

The land area may be divided as follows:

Approximate total area.....	1,127,040 acres.
Virgin timber lands.....	Negligible.
Culled and cut-over lands.....	327,000 acres.
All other lands.....	800,040 acres.

The virgin timber has practically all been cut from Harris County. Timbered areas have been repeatedly culled until such old growth timber as remains is in scattered tracts of mixed hardwoods along the streams.

Culled and cut-over lands support a growth of pine or mixed hardwoods pending upon the character of the soil. For the most part the timber is scrubby and of little commercial value except for fuel.

The greater proportion of the farms are small and are handled intensively. New lands recently put under cultivation are prairie lands. Those cleared from the timbered areas yielded a substantial revenue in cordwood. No improved farm lands have been abandoned and a decided effort has been made to drain those lands where the natural fertility has been counterbalanced by the presence of excessive soil moisture. Improved farm lands range in value from \$20 to \$300 an acre.

By far the largest bodies of land in the county consist of the treeless prairies lying south of the loblolly pine region. They furnish excellent grazing for the local stock industry. Practically all the county is under hog law.

Sawmill operations were begun in Harris County as early as 1882. Thirteen mills, one with 75 to 100 thousand and two approximating 50 thousand each in daily capacity, the remainder being small and irregular in their cut, are now operating. Their combined annual output is small, however, as they operate very irregularly. Houston is the headquarters

for many of the principal lumber companies of eastern Texas and the adjacent States.

The fuelwood industry is a comparatively large one when compared to the meager timber resources of Harris County. Not less than 12,000 cords of wood are consumed annually, most of which is shipped in from the adjoining counties. Practically no other wood using industries handle raw material in the county.

Woodland fires are not a serious problem because of the comparatively small timbered area. Grass fires, however, are extensive on the open prairies.

HARRISON COUNTY.

Harrison County lies entirely within the shortleaf pine region. The land surface, rolling in the western but more level in the eastern portion, drains into the Sabine River and Caddo Lake. Several small, scattered areas of sandstone as well as iron ore deposits are found in the county. Soils vary from light to dark loams and in the main are very productive. Public roads are all graded. Four mainline railroads, with a total mileage of 131 miles, furnish excellent transportation facilities.

The land area may be divided as follows:

Approximate total area.....	558,720 acres.
Virgin timber lands.....	55,000 acres.
Second growth lands.....	55,000 acres.
Culled and cut-over lands.....	190,000 acres.
All other lands.....	258,720 acres.

In the main virgin timber lands support a growth of mixed hardwoods along the streams and in the bottoms. Several small, scattered tracts of pine timber are owned by the local farmers.

Second growth areas date from the earlier logging operations and comprise small, scattered tracts of shortleaf pine in all sections of the county. No importance is attached to the future value of these stands, although timber 20 to 35 years old will soon be of decided value.

Culled and cut-over lands date from 20 years ago to the present time. In accordance with the usual practice late cuttings were heavy and left but little standing timber. Agricultural lands in this class are offered for sale at extremely low prices.

Diversified farming is practiced on Harrison County farms. A small acreage is cleared annually as the general tendency is to abandon older lands and till the newer. Farms average 75 acres in size. In the more hilly sections soils are subject to severe washing. Eroded lands which may be classed as waste constitute a small acreage. All of Harrison County is under hog law and considerable portions have a general stock law.

Lumbering operations have been conducted for about 35 years. Eleven mills, with daily capacities ranging from 10 to 60 thousand feet, produce approximately 20,000,000 feet of lumber annually. At this rate of production and considering the growth on culled and second growth lands these mills may operate indefinitely.

Approximately 75,000 hewn ties, mostly pine, are cut annually. The industry may continue for five or six years before the easily accessible

timber is cut out. In addition to the local consumption of fuelwood about 5,000 cords are annually shipped to El Paso. This industry may continue indefinitely. At the present time mine timbers to the number of 40,000 props are cut each year, but the industry is not so large as the supply of suitable timber warrants. What is probably one of the largest veneer cutting plants in the South is located at Marshall and at least 1,500,000 feet of slack cooperage veneer timber, mostly sweet gum, are consumed annually in this plant. The local timber supply for this industry, however, is limited and prices are consequently high. From \$11 to \$13.50 per thousand is obtained for gum at the mill.

Notwithstanding the fact that grass and woodland fires are not a serious problem in Harrison County there is yet a lack of pine reproduction on the cut-over lands and hardwoods seem to return. Stripping timbered areas under modern logging methods is perhaps the prime factor in limiting more desirable reproduction. Such lands as were cut under early methods now support good stands of pine, which should be merchantable in a few years and constitute the main dependence for a future local supply.

HENDERSON COUNTY.

Henderson County is situated largely within the post oak region, a little more than 10 per cent in the extreme eastern portion being in the shortleaf region. The land surface is generally level and drained by the Trinity River on the west and the Neches River on the east. Soils vary from light loams to heavy, black waxy. Streams for the most part are sluggish and stagnant through parts of the year. Public roads show great improvement. More than 80 miles of mainline railroad serve the county.

The land area may be divided as follows:

Approximate total area.....	601,600 acres.
Virgin timber lands.....	2,000 acres.
Second growth lands.....	Negligible.
Culled and cut-over lands.....	360,000 acres.
All other lands.....	239,600 acres.

Virgin timber areas though small are valuable. Ash of excellent quality is found in the western portion of the county and there are numerous small, scattered areas of cottonwood. The pine timber has practically all been cut out.

Second growth lands occupy so small an acreage as to be negligible. Heavy cuttings have operated to keep down reproduction.

Culled and cut-over areas have been increasing since 1891 and many old abandoned mill sites are to be found in different sections of the county. Although cutting has been heavy within recent years a small percentage of these lands is still capable of furnishing another cut of timber.

Farms in the main are well worked under a system of diversification. A small acreage of new land is cleared annually. No old lands are abandoned. Where markets are not available the timber is still burned in clearing land. Farms average 100 acres in size. There is little erosion on improved lands. Three-fourths of the county is under general stock law.

As contrasted to conditions several decades ago the lumber industry is insignificant. Six small mills combined with cotton gins, five of which

also cut shingles, produce not more than 200,000 feet annually. As the cut is very small and irregular these mills may operate for an indefinite period.

Not more than 100 cars of fuelwood are shipped annually and this industry at the present rate of production may continue indefinitely. The annual production of ties and staves is negligible.

The fire situation in Henderson County is not serious. Shortleaf pine reproduces rapidly in the eastern part of the county if the land has not been entirely stripped of its timber. The hardwood reproduction is generally scrubby and dwarfed due to the prevalence of undesirable species.

HOPKINS COUNTY.

Hopkins County lies entirely within the northern portion of the post oak region. The land surface, generally level to slightly rolling and with but few small hills, is well drained by the Sabine and Sulphur Rivers. Soils vary from light loams to heavy, black prairie lands. Several small areas of iron ore are found in the county. The streams are sluggish and subject to frequent overflow. Public roads for the most part show considerable improvement. Not more than 70 miles of mainline railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	426,240 acres.
Virgin timber lands.....	Negligible.
Second growth lands.....	Negligible.
Culled and cut-over lands.....	170,000 acres.
All other lands.....	256,240 acres.

The areas supporting a growth of virgin timber are so small and the timber itself of such slight commercial value as to be considered negligible. The same may be said of second growth lands.

Culled and cut-over lands are the principal timber type and are found in scattered tracts in all sections of the county. Logging has been carried on for the past 25 years. A comparatively large acreage in this class has been stripped of its timber, thus making reforestation decidedly uncertain. Those areas not cut clean are being cut again at the present time.

Farms show considerable improvement both in methods of management and in appearance. Diversified farming rather than growing the staples is the principal agricultural system. A small acreage in connection with older farms is cleared annually. The timber is shipped for fuel if accessible to the railroads. Farms average 100 acres in size and improved lands are subject to severe washing unless terraced. The entire county is under general stock law.

Lumbering has never been an important industry in Hopkins County. At the present time four small mills are cutting very irregularly, their total output not exceeding 3,000,000 feet annually. At this rate of production the industry may continue indefinitely.

No estimate can be made of the tie output. The industry, however, is not so large as it was several years ago since the white and red oak suitable for ties is practically all cut out. The production of fuelwood totals 120 cars a year and may continue indefinitely at this rate. As the entire

county is under general stock law the consumption of fence posts is small. Some of the smaller mills cut fence posts at odd periods.

The general condition of the hardwood timber is poor by reason of either shake, decay or insects and reproduction is uncertain, more on account of stripping timbered areas and leaving no seed trees than as an effect of fires. Hopkins County should be a farm woodlot county, each farmer producing enough material, at least, for his own needs.

HOUSTON COUNTY.

Houston County is located almost entirely within the shortleaf pine region, a very small acreage in the extreme northwest corner being in the post oak region. The land surface, hilly and broken in the northern portion, but more rolling in the south, drains into the Neches and Trinity Rivers. Soils range from light sand to heavy loams. Large areas of iron ore deposits are found north of Crockett. Public roads are being gradually improved. More than 52 miles of mainline and 40 miles of logging railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	762,880 acres.
Virgin timber lands.....	50,000 acres.
Second growth lands.....	175,000 acres.
Culled and cut-over lands.....	255,000 acres.
All other lands.....	282,880 acres.

The greater proportion of the virgin timber lands are located in the southern and eastern portions of the county and support a growth of pine. The lands are held in large tracts by the lumber companies. Under present logging methods everything down to a six-inch diameter is cut.

Second growth lands are located in the northern and southern portions. Shortleaf pine, particularly where fires are kept out, is slowly reforesting these areas. Only a very small percentage of the area in this class is from old fields. The average stand per acre is light and but little importance is placed upon the future value of this type of timber.

Culled and cut-over lands date back to 1890. Areas logged in the earlier periods were cut lightly and now support stands of from 500 to 3,000 feet per acre. Practically all the merchantable timber is pine. Although little land is being sold at present it is certain that a large acreage in this type will eventually be used for farms.

Progress is now being made in agriculture as contrasted to conditions a decade ago. The general tendency still is to abandon old lands and clear new. Farms average less than 45 acres in size and are subject to severe washing, particularly in the northern portion of the county. Other land areas comprise a large acreage of pasture land in the western portion of the county. Nearly the entire county is under hog law.

Lumbering as an important industry dates back 15 years. Nine mills, one of more than 50 thousand daily capacity, the remainder small and irregular in their operations, are located at the present time within the county while at least three large companies in adjacent counties tram their timber from Houston County. The total production is approximately 75,000,000 feet annually. The industry, however, is slowly giving

way. At least eight mill sites have already been abandoned and at the present rate of production milling operations will finish in about five years.

The operators produce about 30,000 hewn ties annually of which 98 per cent is oak. Waste characterizes the industry and at this rate the available timber will soon be cut out. Not less than 20,000 white oak staves are cut each year, but the industry cannot continue longer than five years. It is estimated that 75,000 cords of fuelwood are consumed in the county annually. The output of fuelwood as well as fence posts is purely local. One shingle mill cuts very irregularly.

Grass and woodland fires are a serious problem in Houston County. Probably two-thirds of the timbered area burns over annually, the fires being started largely to improve the grazing. As a consequence pine reproduces only sparingly and mixed hardwood growth thrives. The future scarcity or abundance of pine timber in Houston County depends upon the control of the fire situation.

JASPER COUNTY.

Jasper County, with the exception of a comparatively small acreage of loblolly pine in the southeastern corner, lies entirely within the longleaf pine region. The land surface is broken in the north, but becomes more level in the southern half. Drainage is chiefly to the west into the Neches River. Streams are subject to frequent overflow. Soils for the most part are sandy although an east and west belt of black land, not more than 10 per cent of the area, extends across the county. Public roads show but little improvement. One hundred and eight miles of mainline and 80 miles of logging railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	625,280 acres.
Virgin timber lands.....	200,000 acres.
Second growth lands.....	22,000 acres.
Culled and cut-over lands.....	278,000 acres.
All other lands.....	125,280 acres.

Virgin timber stands, 95 per cent of which are longleaf pine, the remainder being mixed hardwoods and cypress, are mainly in the northern portion of the county. Timber is mostly held by three non-resident concerns and the logging done by contract, a diameter limit of from eight to ten inches usually being specified. The timber is being removed at the rate of 1,000,000 feet daily.

Second growth stands are mainly from old fields and are located in the southern portion of the county. Approximately 75 per cent of these lands support seedling stands of longleaf pine; about 25 per cent consist of loblolly pine growing on old fields. Fires are not frequent in the type and this condition has been the controlling factor in the reforestation of these lands. The future value of this type of timber is fast becoming recognized.

Lands cut over by early operators still support fair stands of timber. Those logged within the past eight years have been practically stripped. Reforestation on such lands is slow if not entirely lacking because of an insufficient number of seed-bearing trees and the fires which burn over these lands almost annually.

Agricultural operations show much improvement in methods of management. Farms average 25 acres in size. Some new land is cleared each year, but there is a slight tendency to abandon old lands when new lands are cleared. The timber is not burned so extensively when new lands are cleared as was formerly the practice. Where lands are broken and hilly soils are subject to severe erosion. Pasture and waste lands are the result of overflow or erosion. Overflow areas are usually timbered with mixed hardwoods. Pasture areas furnish grazing for large numbers of cattle. There is little or no sentiment in favor of a stock law.

Lumbering operations have been carried on in Jasper County for the past 25 years. Ten mills, eight of which have daily capacities ranging from 50 thousand to 200 thousand feet, the other two being small and irregular in their cut, produce approximately 300,000,000 feet of lumber annually. Two of the large mills, located at Remlig and Bessmay, tram their logs from Newton County. In view of the large acreage of virgin timber and second growth lands it is estimated that the present cut can be maintained for at least eight to ten years.

Turpentine operations cover a territory of about 25,000 acres. Cropping is by the cup and gutter system and immediately precedes the logging. Turpentine areas are burned over each year under the supervision of the operators. The operators produce not more than 132,000 pine, 60,000 hewn red oak and 8,000 hewn white and post oak ties annually. Waste characterizes the cutting, however, and about all of the easily accessible tie timber has been cut out. Two operators produce not more than 60,000 white oak staves per year. At this rate the available stave timber will be cut out in about three years. Fuelwood is cut only for home consumption. A small tool handle industry is carried on by local farmers.

Fire is a serious problem in Jasper County. Grass and woodland areas burn over almost annually and as a consequence pine reproduction on cut-over areas is entirely absent. Black jack, oak and sweet gum are reproducing on such areas rather than the more desirable pine.

JEFFERSON COUNTY.

Only a narrow belt along the extreme northern border of Jefferson County, approximating six per cent of the total land area, lies within the loblolly pine region. The remainder of the county is treeless except for scattered areas of pine on the lighter soils and of mixed hardwoods and pine along some of the streams. The land surface is low and very level. Natural drainage is exceedingly poor and systems of ditches for drainage as well as for irrigating the extensive rice fields are maintained. Soils vary from light sands to heavy, black, clay loams. More than 100 miles of public roads are paved and 500 miles graded. Not less than 100 miles of mainline railroad serve the county. The oil interests are large and grazing is an important industry.

The land area may be divided as follows:

Approximate total area.....	709,760 acres.
Virgin timber lands.....	Negligible
Second growth lands.....	Negligible.
Culled and cut-over lands.....	57,000 acres.
All other lands.....	652,760 acres.



The Butt of a Longleaf Pine Showing the Cup System of Turpentine as now Generally Practiced.



A Turpentine Still in the Longleaf Pine Region.

Virgin timber stands have been culled repeatedly and at the present time the area, if any exists, is so small as to be negligible. Mixed hardwoods in the bottoms, though culled, are of considerable importance.

Most of the larger forest areas may be classed as cut-over and but little merchantable timber except for fuel or ties has been left. Lands in this class are found in both the pine and hardwood types. The practice of burning over the grass and woodlands has precluded natural reproduction.

As soils in the county are fertile truck and fruit growing are becoming important industries. Rice growing, because of the generally poor drainage conditions, is the most important agricultural operation. Of the total improved farm land area not less than 130,000 acres are rice lands. By far the largest single land classification is open prairie land embracing as it does practically all of the region south of the narrow timber belt. Areas of swamp and overflow land also constitute a large acreage. One-fifth of the county is under hog law.

Although at least seven mills are located in the county practically none of them secure their raw material locally. The timber is trammed from the counties to the north. One 75 thousand-foot mill located at Voth trams its timber from Hardin County. One comparatively small plant, however, is milling hardwood timber cut from the bottomlands and bayous. The total lumber output has been disregarded since the cut of the mills has been included in the figures for the adjoining counties.

The production of fuel, fence posts and ties is for local consumption and may be said to be negligible. One handle factory and one box and crate factory are cutting hardwood timber from the bottoms. One shingle factory manufactures cypress shingle stock from local raw material.

Heavy and repeated cuttings have stripped Jefferson County of practically all the merchantable timber. Grass and woodland fires have prevented such reproduction as might otherwise be possible on the cut-over areas. In view of the large acreage of future agricultural lands, the area of prairie land and the condition of the woodland generally the county may be disregarded as a factor in the present or future timber production of East Texas.

LAMAR COUNTY.

Lamar County is located in the extreme northeastern part of the post oak region. The land surface is generally level and drains to the northeast and southeast into the Red and Sulphur Rivers, respectively. Soils vary from light loams to the black, sticky type of the bottomland areas. All soil types, particularly the heavier ones, are fertile. Public roads show considerable improvement. The Red River is navigable to a limited extent. About 97 miles of mainline railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	577,920 acres.
Virgin timber lands.....	Negligible.
Second growth lands.....	120,000 acres.
Culled and cut-over lands.....	133,000 acres.
All other lands.....	324,920 acres.

Virgin timber stands are composed of mixed hardwood growth which for the most part is not of timber size or quality. Fuelwood is practically the only product.

Second growth stands are usually found as woodlots in connection with farm areas. The timber is merchantable only for posts and fuel. None of these areas are from reclaimed old fields.

Culled and cut-over stands, dating back 35 years, comprise slightly the largest single timber type. A small acreage supports a growth of timber which is being cut a second time. A very small acreage is agricultural land and subject to sale.

Although the tendency within the past few years has been toward diversification of farm crops cotton, corn and oats comprise the bulk of the agricultural output. While new lands are being cleared, very little old land is abandoned. In certain sections soils are subject to slight erosion. The acreage of waste land is small while pasture lands occupy a comparatively large part of the county and furnish grazing for large numbers of cattle. All the county is under hog law and some districts have general stock law.

Lumbering operations have been conducted in Lamar County for the past 35 years, but the industry is not now and has never been an important one. At present three small mills produce not more than 400,000 feet annually. This output may continue indefinitely in view of the class of timber which may be utilized.

The entire yearly output of 20,000 hewn oak ties makes an important forest industry. Waste characterizes the cutting, however, and tie operators have used about all the available timber. No fuelwood is shipped, the small output being consumed locally. Fence posts for home consumption are cut locally. Even at the small rate of production the available timber is fast being depleted. Two furniture factories, two box and crate factories and one small tool handle factory are operated in the county. The timber used in these industries, however, is shipped in from Oklahoma and Arkansas.

Although there is but little sentiment either for or against grass and woodland fires only a small acreage burns over annually and the fire problem is not serious. Woodland areas on the other hand have been repeatedly cut over and reproduction is slow and of inferior growth. Lamar County should be a farm woodlot county and grow its local timber supply on the farms.

LIBERTY COUNTY.

Liberty County, with the exception of a very small area of longleaf in the northeast corner, is located within the loblolly pine region. The land surface is quite low and level and drains mostly to the south into Galveston Bay. Soils range from light sands to the deep, black soils of the Coastal Prairie and for the most part are exceedingly fertile. Sulphur mining and oil field operations are among the important industries. Public roads in general are in good condition. One hundred and twenty-one miles of mainline and 45 miles of logging railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	742,400 acres.
Virgin timber lands.....	87,000 acres.
Second growth lands.....	115,000 acres.
Culled and cut-over lands.....	375,000 acres.
All other lands.....	165,400 acres.

Virgin timber stands are composed of loblolly and longleaf pine on the sandy soils and mixed hardwoods along the streams. The best bodies of pine have long ago been cut. The remaining bodies are in the northern portion of the county. There is a tendency in present logging methods to leave trees of less than 10 inches in diameter.

Second growth stands are mostly hardwoods along the streams, although pine is coming in to a limited extent in the northern end of the county. Practically no timber in this class is of old field origin.

Culled and cut-over lands, dating back 35 years, are found in both the pine and hardwood types of timber. Some areas have been logged a second time. Where fires are kept out shortleaf pine reproduction is coming in very fast, particularly in the northern part of the county. Much of this land should be maintained in forest.

The lumber industry has but little influence on farming conditions. Wage scales are set by the rice growers rather than the lumber operators. Farms range in size from 10 to 1,000 acres. Rice culture, diversified farming and fruit and truck growing are being practiced throughout the county where soil conditions are adapted. An adequate system of drainage is the chief need and the problem is being solved by the organization of local drainage districts.

The livestock industry is an important one, approximately 25,000 head of cattle, but only a few sheep and goats, are kept on the open range. Lands not timbered or improved embrace pasture, waste and overflow lands, all of which are used for grazing purposes. One-tenth of the county has hog law.

Sawmill operations in Liberty County began in 1882. Six mills, four of which cut from 60 thousand to 70 thousand feet daily, the remainder being run in connection with cotton gins, produce approximately 40,000,-000 feet of lumber annually.

The tie output approximates 25,000 gum, pine and oak ties per annum. Pine ties are shipped for treatment before using. At the present rate of production tie cutting may continue for two or three years. About 35,000 cords of fuelwood are consumed locally and shipped. In view of the large amount of hardwoods, unmerchantable except for cordwood, the fuel industry may last indefinitely. Local fence post consumption approximates 1,500 yearly and the local supply will satisfy this demand indefinitely. Charcoal burning produces not more than three tons annually which are rafted down the Trinity River. During the past year approximately 300 poles and about the same number of piles were cut in the county.

There is a general sentiment in Liberty County against burning grass and woodland areas and such fires as do start escape when brush is burned in clearing new lands. Stockmen are not in favor of burning the range. Only a very small per cent of the total area burns over annually and as a consequence reproduction of both pine and hardwoods on such lands as

are suitable for their growth is good. If the fire situation is handled in the future as it has been in the past second growth timber will ultimately be available.

MARION COUNTY.

Marion County lies entirely within the shortleaf pine region. The land surface is hilly in the western portion but becomes more rolling in the eastern. Drainage is through the Big Cypress River and Caddo Lake. Several scattered areas of sandstone are found in the county and practically one-third of the entire area is in the iron ore belt. Soils vary from light to dark loams with a red clay subsoil. The public roads are gradually being improved. More than 49 miles of mainline and about 15 miles of logging railroad serve the county. Transportation facilities will soon be improved by barge service through Big Cypress River to Caddo Lake.

The land area may be divided as follows:

Approximate total area.....	245,760 acres.
Virgin timber lands.....	25,000 acres.
Second growth lands.....	35,000 acres.
Culled and cut-over lands.....	100,000 acres.
All other lands.....	85,760 acres.

Not more than one per cent of the virgin stands are pine, the remainder being mixed hardwoods in the river and small stream bottoms. Timber is held both by the large lumber companies and by individual residents. When sold both land and timber are included in the deed.

By far the greater proportion of second growth stands are on old field lands in scattered tracts over the county. The timber in this class is mainly shortleaf pine which has reached tie timber dimensions and is now being cut. The future value of such stands is rapidly becoming recognized.

A second cut is now being made on the older cut-over lands. The later first cuttings as well as the present second cuttings are stripping these lands and oak and gum are taking possession of the areas. While a large percentage of the cut-over lands are suitable for agriculture such utilization is far in the future. Most of such lands are now for sale on very easy terms.

Diversified farming is the practice and general farm conditions are good where the work is being done by resident owners. Practically no lands are being abandoned and a small acreage of new land is cleared annually. Where markets are remote the timber is burned in clearing new land. Farms average 100 acres in size and should be terraced over most of the county to prevent washing. Three-fourths of the county is under hog law.

Lumbering operations have been carried on in the county for the past 35 years. Three mills, one of 60 thousand feet daily capacity, the remainder of the portable type, produce not more than 8,000,000 feet of lumber annually. The one large mill will cut out within a year, but the smaller mills, at their present rate of production, may cut from second growth and cut-over lands for an indefinite period.

Tie operators cut about 150,000 hewn ties annually, more than 75 per cent of which are pine. Two small portable tie mills have recently ceased

cutting. Waste characterizes the industry, but cutting may continue for two or three years at the present rate of production. The production of fence posts and fuelwood is governed entirely by the local demand. One small shingle mill operates very irregularly. The output of other forest products, such as staves, poles, etc., is negligible.

While hardwood reproduction over most of the county is excellent, fires and the practice of stripping timbered areas are responsible for the general lack of pine reproduction. The residents of Marion County should concern themselves with woodlot forestry in connection with the general management of their farms.

MONTGOMERY COUNTY.

Montgomery County is located entirely within the loblolly pine region. The land surface, rolling in the north to level in the south, drains to the southeast through the San Jacinto River. Soils range from light sands in the hilly section to heavy alluvial soils in the bottoms. Areas of black waxy soil are found in the southern prairie section. Undeveloped iron ore deposits are also found in the county. Public roads are in good condition and bond issues give assurance of their future maintenance. One hundred and twenty-eight miles of mainline and 40 miles of logging railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	682,240 acres.
Virgin timber lands.....	160,000 acres.
Second growth lands.....	90,000 acres.
Culled and cut-over lands.....	270,000 acres.
All other lands.....	162,240 acres.

Practically all of the virgin timber is loblolly pine in the northern and western portions of the county. The timber is owned in large tracts by the lumber companies. Some longleaf areas are located in the northeastern portion of the county. Present logging operations are stripping the land.

Second growth lands, in scattered tracts over the county, support a growth of shortleaf pine, sweet gum and black jack oak. A small acreage is in longleaf pine. Although a small acreage of this class of timber has now reached a size suitable for ties, but little importance is placed upon the future value of second growth timber as a whole.

Culled and cut-over lands date from 1881 to the present. Since early logging operations culled the timber lightly a good crop is again being cut from some of these lands. At least half of the cut-over lands are well adapted to agriculture, but the remainder should be reforested. Repeated burning kills what reproduction may start on the areas.

Farming and stock raising are among the principal industries. A small acreage of new land is cleared annually, the timber usually being burned. There is very little labor competition between the millmen and farmers. Farms range in size from 20 to 1,000 acres and are subject to severe washing in the hilly section of the county. A large acreage in the county is prairie land which furnishes excellent grazing for large numbers of cattle and goats. A great deal of Montgomery County is

more valuable for pasture than for farming. Not more than 10 per cent of the total area is under hog law.

The lumber industry is still an important one. Eight mills, two with 100 thousand feet each and one of 50 thousand feet daily capacity, the remainder small, produce approximately 96,000,000 feet of lumber annually. In view of the large area of virgin timber and culled and cut-over lands mill operations may continue for 15 years at this rate of production.

Approximately 635,000 hewn ties are cut annually, practically all of which are pine. Although the annual tie output has increased during the past few years it is estimated that future production will not exceed 400,000 ties. At that rate cutting may be continued for several years. Fuelwood and stave bolt operators annually produce 5,000 and 4,000 cords of fuel and stave bolts, respectively. At this rate these industries may hold out indefinitely.

The general attitude toward the future value of the timber in Montgomery County is one of indifference. Fires are set under the belief that grazing conditions are improved. Many areas burned over, however, are covered with a growth of scrubby hardwoods and are practically barren of grass cover. Hunters and other persons traveling through the woods start many fires. Present logging methods are stripping the timbered lands and leaving no provision for natural reproduction. Under such conditions reforestation is impossible. While those lands which are needed for agriculture should be cleared of their timber growth it is estimated that at least 50 per cent of the total area of the county will not be so used for a long period of years and should be kept in timber. Cut-over lands can be reforested if the fire situation is controlled.

MORRIS COUNTY.

Morris County is located in the northern part of the shortleaf pine region. The land surface is broken and hilly in the south, but rolling to level in the north. Drainage is into the Sulphur and Big Cypress Rivers. Several small areas of sandstone are found in the county. Large iron ore deposits are located in the southeast portion. Soils range from light loams to those of the heavy, dark, river bottom type. Public road conditions are slowly improving. There are more than 21 miles of main-line railroad.

The land area may be divided as follows:

Approximate total area.....	177,920 acres.
Virgin timber lands.....	8,000 acres.
Second growth lands.....	10,000 acres.
Culled and cut-over lands.....	25,000 acres.
All other lands.....	134,920 acres.

Virgin timber lands for the most part support a growth of mixed hardwoods, mostly white oak, the best bodies being along the streams. The small acreage in virgin pine timber will be cut within a year.

Second growth lands are timbered with shortleaf pine and mixed hardwoods and are most abundant in the north. While the greater proportion

of the timber is not of merchantable size the areas are being protected because of the recognized future value of the timber.

Culled and cut-over lands date from 30 years ago to the present time. Large areas now support a growth of non-merchantable timber, but probably two-thirds of the cut-over lands will eventually produce another crop of pine timber. This is due largely to the fact that public sentiment is strongly against burning over the woodlands.

Staple crops, such as cotton and corn, are the main dependence of the farmers. Farms average 100 acres in size although several contain 1,000 to 3,000 acres. A small acreage of new land is being cleared annually. Farmlands are subject to severe washing in the hilly section of the county. All of the county is under general stock law.

Lumbering operations have been carried on for more than 25 years. Four small portable mills are cutting at present with a total annual output of only 2,500,000 feet. Even with such a small production pine mill operations cannot continue on their present scale. When second growth timber becomes merchantable there will be a revival of the lumber business.

The tie industry is fast disappearing. Not more than 20,000 ties, of which 90 per cent are pine, are cut annually. Fuelwood shipments approximate six to eight cars per annum. Shingle operators produce not less than 4,000,000 shingles a year, most of which are shipped. The shingle cut and the production of fuelwood are probably the only present wood-using industries which may continue for an appreciable period.

Shortleaf pine reproduces abundantly and there is a general sentiment against burning the grass and woodlands. Although present timber stands have been culled heavily the general protection afforded cut-over areas will be an important factor in insuring a second growth.

NACOGDOCHES COUNTY.

An east and west line drawn through Nacogdoches County a little south of its center would divide the commercial ranges of longleaf and shortleaf pine in the county. The land surface, very broken and with many fertile valleys, drains into the Attoyac and Angelina Rivers. Soils range from light, loose sands to heavy, black waxy. Approximately 35 per cent of the area consists of red land. Although there is no special tax or bond issue for public road improvement the roads are gradually being bettered. One hundred and five miles of mainline railroad serve the county.

The land area may be divided as follows:

Approximate total area.....	615,680 acres.
Virgin timber lands.....	240,000 acres.
Second growth lands.....	25,000 acres.
Culled and cut-over lands.....	120,000 acres.
All other lands.....	230,680 acres.

The area of virgin timber lands comprises 120,000 acres of shortleaf pine, 30,000 acres of longleaf pine and 90,000 acres of mixed hardwoods. The hardwood stands, however, have been culled to some extent and might be so classed. Present timber sales include both the land and timber. In view of the large acreage and comparatively heavy stands of

virgin timber, particularly in the pine types, it is estimated there is sufficient to allow for a 20-year cut at the present rate of consumption.

Second growth areas are mainly old fields which are reforesting to pine. The timber on such lands at present is only merchantable for ties.

Culled and cut-over lands date from 20 years ago to the present time and have been culled heavily. A large acreage of these lands is suitable for agriculture, but will probably not be so utilized for many years. At present the cut-over areas present a sorry appearance stripped, as they have been, of their timber.

Farms range from 20 to 500 acres in size. Truck growing, stock raising and the production of staples, such as cotton and corn, are the principal farming activities. New lands are slowly being cleared and except where



Reproduction of Longleaf Pine on Protected Cut-over Lands.

timber can be easily hauled to the railroad it is burned on the ground. Some farm lands have been abandoned where severe erosion has taken place. One-half the county is under hog law and the sentiment is rapidly growing.

Mill operations have been conducted on a more or less extensive scale for about 20 years. Three large mills are located in the county and one company trams its logs to Angelina County. The present annual cut is 75,000,000 feet.

Although turpentine is not at present carried on, there is a good opening for the industry in Nacogdoches County. The tie output during the past year totaled 15,000 ties, 90 per cent being pine and 10 per cent

white and post oak. In view of the large acreage of mixed hardwoods, even though the stands have been culled, the stave industry should be a flourishing one. Unsettled markets, however, have limited production. Fence posts and fuelwood are cut only for home consumption.

Only a small part of the county burns over annually. Most fires start where new lands are being cleared. In well settled communities care is taken to restrict fires and several instances are on record where suit has been brought and damages collected for negligence in this respect. As a consequence woodland areas are reproducing fairly rapidly where sufficient seed bearing trees were left by previous logging operations.

NEWTON COUNTY.

Newton County, except a small portion of the loblolly region in the extreme south, is located entirely within the longleaf pine region. The northern half of the county is broken; the southern half is comparatively level. Soils vary from light, sandy loams in the north to darker loams in the south. An extension of the black land belt of Jasper County traverses Newton County from west to east. The land surface drains into the Sabine River. Newton County has 70 miles of frontage on this river. About 42 miles of mainline and 45 miles of logging railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	577,920 acres.
Virgin timber lands.....	175,000 acres.
Second growth lands.....	20,000 acres.
Culled and cut-over lands.....	296,000 acres.
All other lands.....	86,920 acres.

Virgin timber stands are mainly longleaf pine of excellent quality. Approximately 100,000,000 feet of mixed hardwoods are located along the Sabine River and in the creek bottoms. The largest tracts of pine are located in the north-central section and are held by non-resident owners.

Second growth lands are of old field origin. The best stands in this type are located in the southern portion of the county. Little importance is placed upon the future value of the timber.

Culled and cut-over lands support a more or less heavy stand of timber depending upon the period in which they were logged. Lands cut over under early methods were logged lightly and in many cases will now furnish a second crop. Those cut under present methods have been stripped of their pine timber and are reproducing to a growth of scrub oak and gum with but little longleaf pine in the mixture. Lack of sufficient seed bearing trees and the practice of burning over the woodlands make it impossible for such areas to reproduce to pine.

Lumbering has retarded agricultural development in Newton County. Conditions, however, are constantly improving. No old farm lands are abandoned and a small acreage of new land is being cleared annually. Where new lands are cleared the timber is generally used for fuel. Average farm tracts are 100 acres in size with approximately 20 per cent in cultivation. In the broken, hilly section farm lands are subject to severe washing. No part of the county is under stock law. Pasture, eroded and

overflow lands occupy a comparatively large area and furnish excellent grazing since there is no general stock law.

Sawmill operations date back about 20 to 25 years. Two large mills and three small mills are located in the county. In addition, two large mills in Jasper County tram their raw material from Newton County. The annual output of lumber is at least 125,000,000 feet. At the present rate the larger mills will cut out in 10 to 15 years. Waste in the small mills is used for fuel both by the mill operators and nearby land owners.

Turpentine is not a large industry in Newton County; only 7,500 acres are now cropped. Operations are on the decrease and will hardly last longer than five or six years. The cup and gutter system is used, timber is cut immediately following the cropping and crop areas are burned over annually.

The tie industry is stronger at this time than at any other previous period. Approximately 50,000 pine, 22,000 red oak and 3,000 white and post oak ties are cut annually. Even at this rate the cutting may continue indefinitely as more timber becomes easily accessible. About 2,500 cords of fuelwood are produced and sold in the county each year. One stave operator cuts approximately 60,000 white and post oak staves yearly. The industry cannot last longer than three or four years.

In general enough pine seed trees are left standing on the cut-over areas to furnish ample seed for restocking the land, but as long as fires run unrestricted through the woodlands reproduction of pine is impossible. There is a sentiment against burning the woodlands and a strong belief that burning injures the grazing, but no definite steps are taken locally to prevent such burning. About 75 per cent of the longleaf pine reproduction of the past few years has recently been destroyed. Such conditions will be repeated until promiscuous burning is stopped.

ORANGE COUNTY.

The northern half of Orange County is within the loblolly pine region. The land surface is low and level and, for the most part, insufficiently drained. Soils vary from light loams to the black prairie soils typical of the Coastal Prairie. All public roads are graded and several main roads have been gravel surfaced. More than 100 miles of mainline railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	250,880 acres.
Virgin timber lands.....	32,000 acres.
Second growth lands.....	36,000 acres.
Culled and cut-over lands.....	83,000 acres.
All other lands.....	99,880 acres.

Virgin timber stands are located in the northern portion and consist chiefly of pine of which there is estimated to be a stand of approximately 200,000,000 feet. The timber is held in large tracts, about 20 per cent by non-resident owners.

Second growth lands, where protected from fire, are slowly being reforested. Although loblolly pine is normally a fast growing species, repeated burnings retard the growth, often killing the trees outright, and as

a consequence second growth pine stands in Orange County do not assume the importance they should.

Culled and cut-over lands, dating back ten years, have for the most part been culled lightly and now often support a comparatively heavy stand of timber. Large areas of this type are adapted to farming, but the lands are not on the market.

Of the total improved farmland area 15,000 acres are irrigated rice lands. The area south of the loblolly pine region consists of prairie and marsh lands which on the whole are treeless. A small area is under hog law.

Lumbering operations date back many years; the city of Orange was the seat of many of the earlier mill operations in Texas and is still a great lumber center. Five mills are at present operating in the county. One of these mills, probably the largest in Texas, trams its timber from Louisiana. Another large mill cuts in adjoining counties while three are cutting timber within the county. The timber cut from Orange County approximates 20,000,000 feet annually and at this rate should hold out ten years longer.

Probably the only paper mill in Texas, engaged in the manufacture of kraft paper from waste yellow pine, is located at Orange. This company is annually turning waste material from several large sawmills into a commercial paper of recognized merit.

Only a small area of Orange County is under stock law and vast areas of grass land are burned over annually, little thought being given to the protection of woodlands. This condition may be assigned as the reason for the absence of reproduction and the poor condition of second growth lands.

PANOLA COUNTY.

Panola County lies entirely within the shortleaf pine region. The land surface, broken and hilly in the north but becoming more rolling in the south, drains into the Sabine River. Soils range from light to dark loams with a comparatively large area of black bottomland along the streams. All main public roads are in excellent condition. More than 49 miles of mainline railroad traverse the county. Streams for the most part are wide and shallow and subject to frequent overflow.

The land area may be divided as follows:

Approximate total area.....	520,960 acres.
Virgin timber lands.....	105,000 acres.
Second growth lands.....	50,000 acres.
Culled and cut-over lands.....	175,000 acres.
All other lands.....	190,960 acres.

A large area of virgin shortleaf pine is located in the eastern portion of Panola County and a heavy stand of valuable hardwoods is found along the Sabine River. Practically the entire stand of virgin timber is owned by the large mill companies.

Second growth lands support stands of shortleaf pine and mixed hardwoods. Lands in this type are located almost entirely in the western portion of the county, the exception being a small scattered acreage of old fields. While but little importance is attached to the future value

of second growth timber, it is estimated that these stands, particularly those on old fields, will now cut from 1,000 to 3,000 feet per acre.

The greater portion of culled and cut-over lands date back more than 20 years. The best of these are located in the southern portion of the county and will cut from 2,000 to 3,000 feet per acre. They are owned by local residents and farmers. Cut-over lands of recent origin have been cut clear and are practically denuded of their timber.

Agricultural conditions are improving although but little new land is being either settled or cleared. None of the present improved lands are being abandoned. Farm lands, particularly in the more hilly portions, are subject to severe washing. Three-fourths of the county is under hog law.

Lumbering operations have been carried on for the past 30 years, but have greatly decreased within the past decade. Eight small mills, two of them operated in connection with cotton gins, produce not more than 24,000,000 feet annually. At this rate of production, however, they may operate indefinitely.

The production of ties is decreasing because of the inaccessibility of suitable timber. The present output approximates 65,000 ties per year, the greater percentage of which are pine. All ties are hewn and pine ties are treated before using. The industry may continue indefinitely as it is entirely probable that a way will be found to market timber hitherto considered inaccessible. One operator cuts about 300,000 white oak staves yearly, with a supply in sight to last 15 years longer. Fuelwood and fence post production are governed by the local demand. The same may be said of the output of telephone and telegraph poles and shingles.

Only a very small amount of the total woodland area burns over annually. As a consequence shortleaf pine is reforesting those cut-over lands which have not been stripped of their timber by recent logging operations.

POLK COUNTY.

Polk County lies entirely within the longleaf pine region although the southern and southwestern boundaries practically limit the western range of this species in commercial quantities. The land surface, generally broken and hilly but fairly level in the southern and central portions, drains to the east and south through the Neches and Trinity Rivers, respectively. Soils vary from a light sand to black waxy. Some areas of very fertile bottomland soils are found. Streams are large with little tendency to overflow. Public road conditions are improving. Ninety-four miles of mainline and 89 miles of logging railroad are operated in the county.

The land area may be divided as follows:

Approximate total area.....	704,000 acres.
Virgin timber lands.....	150,000 acres.
Second growth lands.....	25,000 acres.
Culled and cut-over lands.....	425,000 acres.
All other lands.....	104,000 acres.

Virgin timber stands are longleaf pine. Stumpage is held in large tracts under non-resident ownership. Present logging methods cut the

timber clean, practically no trees being left for natural seeding. Timber deeds run for 20 years. The bodies of virgin timber are scattered and practically all of the timber easily accessible to the railroads has been cut out.

Second growth lands are located in the southern part of the county. Practically the entire acreage is from abandoned old fields. The future value of the timber is not recognized.

Culled and cut-over lands occupy a large acreage in the county. Early logging operations left a fair stand of timber on some of these areas, probably from 300 to 1,000 feet per acre. Areas logged within the past ten years have been cut clear and in most cases are not reproducing. Lands in this type lie along the main railroad lines and are easily accessible.

Agricultural operations are becoming more and more important and methods of farm management are improving. Farms range from 20 to 200 acres in size. New lands are cleared each year and the timber burned in the process. Farm lands in the hilly sections must be terraced to prevent washing. No part of the county is under stock law.

Lumbering operations have been carried on in Polk County for 35 years. Seven mills, five of which cut from 75 to 190 thousand feet daily, the other two, being comparatively small and irregular in their cut, produce 150,000,000 feet annually. The mill cutting 190 thousand daily includes approximately 40 thousand feet of hardwoods. One of the largest mills in Liberty County trams its logs from Polk County. At the present time several of the larger mills have cut out their Polk County holdings while others may continue cutting for 15 or 20 years.

Turpentine operations cover 160,000 acres. Not more than 12,000 pine and 5,000 oak ties are cut each year, the majority being hewn. All pine ties are shipped for treatment. The cutting is exceedingly wasteful and at the present rate the tie industry cannot last longer than two or three years. The stave production approximates 150,000 white, red and post oak staves per annum. At this rate the industry cannot long continue. Not more than 2,000 cords of fuelwood are used locally and shipped. The supply of timber for fence posts may last indefinitely as not more than 10,000 are used locally each year. One shingle mill and one other small plant have an irregular output.

The woodlands of Polk County are practically barren of pine reproduction as a result of clear cutting and fires. Oak and gum are increasing as a result of burning. Where forest lands have been cut clear and then burned over, surface erosion is evident. There is little value placed upon the second growth of timber which may be derived from protected areas and sentiment in the county seems strongly in favor of burning the grass and woodlands.

RED RIVER COUNTY.

By far the greater proportion of virgin timber lands are mixed hardwood area, lies within the post oak region while the remainder is within the shortleaf pine region. The level or slightly rolling land surface is drained by the Red and Sulphur Rivers. Soils range from light loams to heavy, black waxy and for the most part are very fertile. Public roads are in excellent condition. More than 48 miles of mainline railroad serve the county.

The land area may be divided as follows:

Approximate total area.....	679,040 acres.
Virgin timber lands.....	75,000 acres.
Second growth lands.....	Negligible.
Culled and cut-over lands.....	134,000 acres.
All other lands.....	470,040 acres.

By far the greater portion of virgin timber lands are mixed hardwoods located in the southern portion of the county. The timber and land are held in large bodies. Valuable stands of ash are found in small, scattered tracts on the bottomland areas and a large quantity of Bois d'Arc, estimated at more than 1,000,000 feet, grows on the prairies.



The Use of Portable Sawmills Increases as Large Mill Operations Disappear.

Culled and cut-over lands, dating from 35 years ago to the present time, are located in practically all sections of the county. A very small acreage in the class is being cut over a second time. Much of the cut-over land is well adapted to agriculture.

Because of the generally fertile soils in the county a large acreage is devoted to diversified farming and cotton growing. Farms range in size from 100 to 3,000 acres. Improved farm land values, though high, are entirely commensurate with their productivity. Practically all the county is under hog law.

The lumbering industry in the county is an old one, dating back more than 35 years. At the present time, however, seven small mills produce not more than 4,500,000 feet of lumber annually. Waste in the mills is

utilized for fuel. At the present rate of production the industry may last indefinitely.

Although 100,000 hewn oak ties are cut annually, the industry cannot continue at this rate. Fuelwood to the extent of 1,500 cords yearly is consumed locally and shipped out of the county. Comparatively few fence posts are used because of the general stock law. The cutting of hardwood bolts for handle stock constitutes a small industry, but the output is irregular.

Pine timber has practically all been cut out of Red River County. Grass and woodland fires, with their usual effect upon pine reproduction, are not a serious problem. The stripping of timbered areas, thus leaving no provision for a second growth, is a problem which should be guarded against on the remaining timber holdings. Each farm should include a woodlot for growing home supplies of the future.

RUSK COUNTY.

Rusk County lies in the southern part of the range of shortleaf pine.

The land surface, very hilly and broken in the north and west but becoming more rolling in the south, drains into the Sabine and Angelina Rivers. Deposits of iron ore are found in the hilly sections. Soils range from light to dark loams. Public roads show but little improvement. Approximately 53 miles of mainline railroad are located in the county.

The land area may be divided as follows:

Approximate total area.....	585,600 acres.
Virgin timber lands.....	180,000 acres.
Second growth lands.....	25,000 acres.
Culled and cut-over lands.....	140,000 acres.
All other lands.....	240,600 acres.

Most of the area indicated as virgin timber lands supports a stand of unmerchantable black jack oak. The only virgin timber of commercial value now standing in Rusk County is about equally divided between shortleaf pine and mixed hardwoods. The best bodies of pine are located in the southeastern portion of the county and are owned in large tracts by the lumber companies. Timber deeds do not include the land and ten years is allowed for the removal of the timber.

Second growth lands support a stand of shortleaf pine and mixed hardwoods. The best bodies are located in the eastern and southern portions of the county. A little old field growth is included in this type, but by far the greater percentage is from culled lands. The value per acre on the culled lands ranges from 1,000 to 3,000 feet.

Culled and cut-over lands date from 30 years ago to the present time and the severity of cutting is directly proportional to the time of cutting. For the most part lands cut over under early logging methods now support fair stands of timber and will furnish a second crop within a comparatively short time. Later logging operations stripped the land.

Farms range in size from 40 to 500 acres and are devoted to general farming and truck growing. Agricultural operations are improving. A few new settlements are made each year with their consequent clearing operations. Unless near the railroads timber is burned when new land

is cleared. A large area of improved lands is subject to severe washing. A small acreage of hilly, sandy land which supports neither grass nor timber is located in the southern portion of the county. Three-fourths of the county is under hog law and three districts are under general stock law.

Sawmill operations have been conducted in Rusk County for more than 30 years. Twelve mills, two with daily capacities of 40 thousand feet each, the remainder small and irregular in their cut, produce approximately 24,000,000 feet annually. This cannot be maintained more than five years although small mills will probably operate indefinitely.

Tie operators produce not more than 18,000 hewn ties annually, practically the entire output being pine. It is estimated that the easily accessible timber will be cut out within the next three to five years. Fuelwood and fence post production are limited as the demand is purely a local one. Not more than 5,000 mine props are cut and shipped annually. There is a small local industry in telephone and telegraph poles, shingles and small tool handles.

Because of the well settled condition of the county and the trend of public sentiment, grass and woodland fires are not a serious menace to the timber lands. Areas which have not been stripped of seed-bearing trees are reproducing naturally. No sheep or goats are kept on the open range and this also operates to protect seedling trees. Conditions for a second growth of both shortleaf pine and hardwoods are exceptionally favorable.

SABINE COUNTY.

Sabine County, with the exception of a very small acreage in the extreme northern portion which lies within the shortleaf pine region, is located in the longleaf region. The land surface is very broken with numerous small hills. Drainage is mostly to the east into the Sabine River. Approximately 15 per cent of the county's area is red land soil, the remainder consisting of various types of sandy loams and bottomland soils. Public roads show but little improvement. About 30 miles of main-line and 20 miles of logging railroad have been built in the county.

The land area may be divided as follows:

Approximate total area.....	369,280 acres.
Virgin timber lands.....	255,000 acres.
Second growth lands.....	14,000 acres.
Culled and cut-over lands.....	30,000 acres.
All other lands.....	70,280 acres.

About 90 per cent of the virgin timber lands, which are located in the eastern portion of the county, supports a stand of longleaf pine which may be considered the finest single body of this species in East Texas. An area of mixed hardwoods is also included in this class. It is estimated that at least 75 per cent of these lands is held in large tracts by the lumber companies.

Second growth lands are for the most part located in the western section of the county along the railroad. The stands are mainly mixed hardwoods with a small proportion of pine. No importance is attached to the future value of the now immature timber.

Heavily culled and cut-over lands are reproducing to a mixed growth of red and black jack oak and gum. Although a large part of these lands is suitable for agriculture, the clearing of new land is not taking place rapidly.

Agricultural operations are secondary to the lumber industry because of the higher wage scale in the mills. A number of farms have been abandoned within recent years although a small acreage of new land is cleared annually. Farms average 80 acres in size. Improved lands, unless terraced, are subject to severe washing. About twenty square miles are under hog law.

Lumbering as an important industry dates back not more than ten years, although some operations have been carried on for a considerably longer period. The comparative newness of the industry accounts for the large acreage of virgin timber. Nine mills, three with daily capacities of 75 thousand, 125 thousand and 175 thousand feet each, the remainder small local mills, produce approximately 60,000,000 feet of lumber annually. The large mills are conducted under the most efficient methods, thus minimizing the usual waste. At the present rate of production the industry may continue for about 20 years.

Two turpentine operators are at present cropping the timber over 8,300 acres in Sabine County. An additional 30,000 acres has been leased and will be cropped by sections in the near future. The cup and gutter system is used. About 120,000 ties, 75,000 of which are pine, 6,000 gum, 19,000 red oak and 25,000 white oak are cut annually. Practically all ties are hewn and pine ties are shipped for treatment before using. Many ties are rafted down the Sabine River. At the present output the tie industry may last for many years. Two stave operators are cutting in the neighborhood of 120,000 staves per annum, of which approximately 80 per cent are white oak. Stave timber is bought by the tree at an average price of \$1. This industry may continue indefinitely.

Grass and woodland fires are a serious problem in Sabine County and second growth pine stands are negligible. Although there is a comparative abundance of virgin timber the cut-over lands should be protected from fires and allowed to reforest.

SAN AUGUSTINE COUNTY.

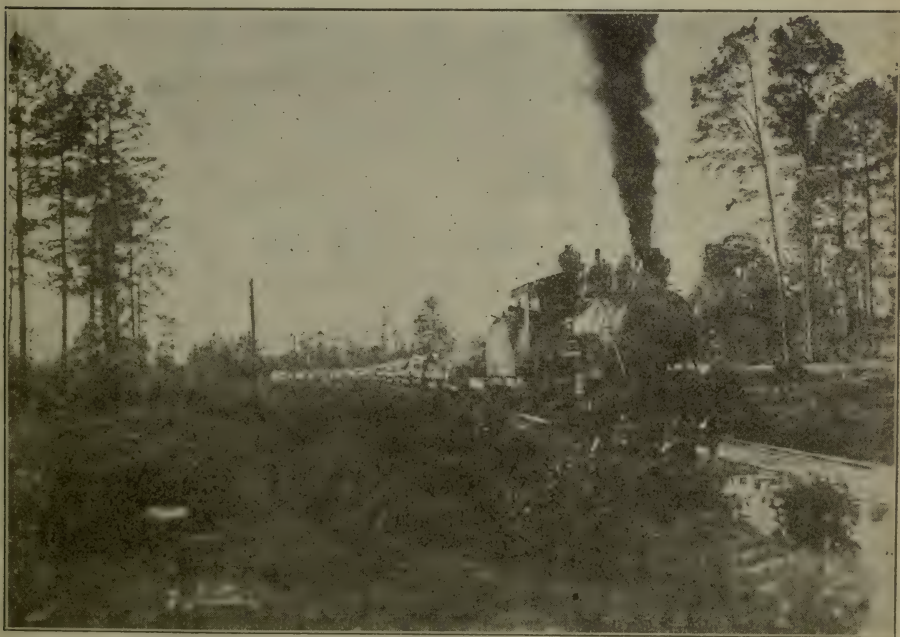
San Augustine County is the common meeting ground for shortleaf and longleaf pine. The northern portion is in the shortleaf pine region while the central and southern portions are in the longleaf region. The land surface is broken and hilly and drains to the south and west into the Angelina River and Attoyac Bayou. Soils vary from those of the red land type in the north to the more sandy soils of the longleaf region in the south. Public road conditions are improving. About 34 miles of main-line and 28 miles of logging railroad are operated in the county.

The land area may be divided as follows:

Approximate total area.....	364,800 acres.
Virgin timber lands.....	160,000 acres.
Second growth lands.....	15,000 acres.
Culled and cut-over lands.....	35,000 acres.
All other lands.....	154,800 acres.



Loading Cars of Logs with a Steam Loader.



A Trainload of Pine Logs on the Way to the Sawmill.

The virgin timber consists of longleaf pine in the central and southern portions, mixed hardwoods (estimated 50,000,000 feet) through the central section in the bottomlands and not less than 8,000,000 feet of cypress adjacent to the town of San Augustine. Practically none of this timber, except the pine, is being cut at the present time. The major portion of virgin timber is owned by the large mill companies.

The best areas of timber in the second growth type are located in the central portion of the county. These lands, although no thought is given to the future value of the timber, now support a thrifty growth of longleaf and shortleaf pine, sweet gum, and oak.

The greater percentage of culled and cut-over lands are of recent origin. These lands are slowly being reforested with red and black oak and sweet gum with a small percentage of shortleaf and longleaf pine in the mixture. The absence of pine reproduction is due to the practice of burning these areas and to the scarcity of seed trees left after logging.

Farms although small show considerable improvement within the past decade. New lands are slowly being cleared and no old lands are being abandoned. Improved farm land soils are subject to severe washing unless terraced. Pasture and waste lands are usually found in connection with farms. No value is placed upon them although they furnish good grazing to free ranging stock. About one-fourth of the county is under hog law; the sentiment is rapidly growing.

Lumbering operations have been carried on in San Augustine County for at least fifteen years. Four mills located in the adjoining counties tram their logs from this county. Six local mills are cutting at the present time. The total lumber output of the county is not less than 150,000,000 feet annually. At this rate of production the large mills may continue for perhaps 10 years and several smaller mills indefinitely.

Approximately 5,000 acres are now being cropped for turpentine, the cup and gutter system being used. Tie operators produce not more than 6,800 pine, 1,300 oak, and 400 gum ties annually. This industry is not so large as it has formerly been, but may continue at this rate for several years.

As a conservative estimate 50 per cent of the total grass and woodland area burns over annually and this in spite of the fact that general sentiment is strongly opposed to burning. Pine reproduction is taking possession of protected areas and in such places a second crop is assured.

SAN JACINTO COUNTY.

San Jacinto County lies within the northern portion of the loblolly pine region. The land surface, rolling in the western and central portions but becoming more nearly level in the east, drains into the Trinity and San Jacinto Rivers. Soils vary from light sand to black waxy and heavy river bottom soils. An outcrop of sandstone rock is found in the central section. Bond issues for public road improvement have been issued in two road districts. About 13 miles of mainline and 40 miles of logging railroad serve the county.

The land area may be divided as follows:

Approximate total area.....	407,040 acres.
Virgin timber lands.....	7,000 acres.
Second growth lands.....	40,000 acres.
Culled and cut-over lands.....	300,000 acres.
All other lands.....	60,040 acres.

The virgin timber is nearly exhausted. Those areas remaining support a growth of loblolly pine and are located mainly in the north-central portion of the county. Timber and land are usually held under the same ownership by the mill companies.

Second growth lands are reproducing to pine for the most part, although gum and oak are found in the mixture. The best areas in this type, although the timber is not yet of merchantable size, are located in the southern and central sections. A small acreage is from old fields.

Culled and cut-over lands date back 15 to 30 years. The timber remaining is pine and mixed hardwoods. The greater percentage of these lands is less suited to farming than to grazing or timber growing.

The lumber industry has little, if any, effect upon agricultural operations. Some new land is cleared annually; several farms abandoned within the past decade have been put back under cultivation. Farms average 25 acres in size. Improved lands are subject to erosion unless preventive measures are taken. No part of the county is under stock law or is likely to be in the near future.

Sawmill operations were begun in 1882. At the present time three mills, one with 80,000 feet daily capacity, the other two of the small local type, produce not more than 24,000,000 feet annually. At this rate milling operations may continue for not longer than five years.

About 7,000 pine and 1,000 hewn hardwood ties are cut annually. The industry may be expected to continue indefinitely. One stave operator produces 25,000 white oak staves yearly. Fuelwood production totals approximately 900 cords yearly and should last indefinitely. About 10 cars of charcoal and 400 pieces of piling and hardwood ship timbers are produced annually.

Public sentiment is not in favor of burning the grass and woodlands. As a consequence pine reproduction is thrifty over the greater portion of the county. The stockmen are decidedly opposed to burning the range. Conditions for a second crop of pine are exceedingly favorable in San Jacinto County.

SHELBY COUNTY.

Shelby County lies entirely within the shortleaf pine region. The land surface is rolling, with a few high hills in the western section, and two-thirds of the drainage is into the Sabine River. Upland soils are sandy loams with a red clay subsoil. Public roads are undergoing gradual improvement. Approximately 96 miles of mainline and 20 miles of logging railroad are operated in the county.

The land area may be divided as follows:

Approximate total area.....	520,960 acres.
Virgin timber lands.....	150,000 acres.
Second growth lands.....	25,000 acres.
Culled and cut-over lands.....	176,000 acres.
All other lands.....	169,960 acres.

The virgin timber is located in the eastern portion of the county and consists of shortleaf pine, mainly in two large tracts. These stands will cut from 6,000 to 8,000 feet per acre. In a few cases, where stumpage alone is bought, timber deeds allow 10 years for the removal of the timber. An extension clause, however, is usually included in the deed.

Practically the entire area of second growth lands is from old fields. The tracts are scattered and support a growth of shortleaf pine. The value of the second growth timber is fast becoming recognized.

Culled and cut-over lands are located in both the northern and southern portions of the county. Culled lands for the most part support a growth of shortleaf pine and a quantity of oak suitable for fuel, fence posts and, in some instances, ties. Cut-over lands, dating back one to five years, are located mainly in the western section. Areas in this type are reforesting with a growth of post oak and black jack oak, but only a little pine. Most of the land in this class should be kept in timber.

Farming operations tend toward diversification. While but little new land is cleared annually there is no tendency to abandon old lands. Farms range from 140 to 200 acres in size and in the main are well kept and show prosperity. Cultivated lands, in the hilly portions particularly, are subject to severe washing, but the farmers have learned the value of preventive measures. About one-third of the county is under hog law.

The lumber industry in the county dates back not less than 25 years. Eleven mills, one of which cuts 220 thousand feet daily but the remainder small and irregular in their cut, have at this time an annual output of not less than 75,000,000 feet. The largest mill now operating has timber enough to last for 25 years. Waste from the mills is used for fuel by both the operators and the nearby farmers. Most of the smaller mills are run in connection with cotton gins.

Tie operators produce about 10,000 ties per year, but this output is far short of what has formerly been the cut. Nearly all ties are hewn, the exception being the product of one small tie mill. Eighty-five per cent of the ties cut are pine, the remainder being equally divided between red, white and post oak, and gum. The tie industry at its present rate of production may last many years. Fuel, fence posts, and other forest products, such as telephone and telegraph poles, are cut for local consumption and in view of the comparatively small extent of the industries will last indefinitely. The stave industry is about exhausted, due to scarcity of either suitable or available timber.

Grass and woodland fires are common and a great portion of the county burns over at least once every five years. This condition coupled with the practice of stripping cut-over areas has operated to prevent the reproduction of pine and increase the growth of scrub oak and weeds.

SMITH COUNTY.

The entire area of Smith County, with the exception of the north-western corner which lies in the post oak region, is located within the shortleaf pine region. The land surface is rolling and drains to the north and south into the Sabine and Neches Rivers, respectively. Soils vary from light colored loams and red land soils to those of the bottomland type.

Nearly \$600,000 has been spent on the public roads and they are all in good condition. About 100 miles of mainline railroad serve the county.

The land area may be divided as follows:

Approximate total area.....	629,700 acres.
Virgin timber lands.....	Negligible.
Second growth lands.....	Negligible.
Culled and cut-over lands.....	355,000 acres.
All other lands.....	274,700 acres.

The acreage of virgin timber lands is negligible as the woodlands have been cut over and culled repeatedly.

Small, scattered, old field areas of second growth are found throughout the county. No importance is placed upon the future value of the timber.

Practically all of the timbered area of Smith County may be classed as either culled or cut-over. In the neighborhood of 120,000 acres of culled lands now support stands of from 1,000 to 2,000 feet of shortleaf pine and mixed hardwoods per acre. Of this timber a good quality of gum is available for box and crate manufacture. Cut-over lands date back 35 years. Lands in this type embrace the bottomland hardwood areas as well as the pine uplands which have been cut heavily. About half of them are well suited for agricultural purposes.

Truck and fruit growing are the principal farming activities. New land is being cleared in all portions of the county and practically no old abandoned lands are found. Timber is sold for fence posts and fuel when new lands are cleared. Farms for the most part are small in size. Although improved lands are subject to severe erosion, this condition is corrected by terracing. The entire county is under general stock law.

Lumbering operations have been carried on for the past 35 years. Ten small mills, operating very irregularly, produce not more than 10,000,000 feet annually. At this rate the industry should be continuous.

Although there is an estimated stand of timber capable of producing over 1,000,000 ties, the industry is practically at a standstill because of the inaccessibility of the timber. Fuelwood consumption averages 5,000 cords yearly. The general stock law which prevails greatly limits the fence post production for local use. A few cars are shipped out of the county each year. One box and crate factory operates very irregularly.

The fire problem is not serious in Smith County. Only a comparatively small acreage burns over annually and wooded areas for the most part are reproducing. Shortleaf pine, sweet gum, and several species of oak are slowly reforesting cut-over areas.

TITUS COUNTY.

Titus County is located entirely within the shortleaf pine region. The land surface is slightly rolling, with some small hills, and is drained through White Oak Creek and Big Cypress River. Soils are sandy loams with some heavier bottomlands which are highly productive. Public roads are being improved; at least three road districts have expended \$300,000 to this end. Not more than 52 miles of mainline railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	269,440 acres.
Virgin timber lands.....	Negligible.
Second growth lands.....	20,000 acres.
Culled and cut-over lands.....	60,000 acres.
All other lands.....	189,440 acres.

Virgin timber lands have all been cut over with the possible exception of small areas of more or less unmerchantable hardwood growth.

Second growth stands consist of mixed hardwoods and small, scattered areas of pine. The future value of second growth timber is given little consideration.

Culled and cut-over lands were formerly timbered with a growth of pine or mixed hardwoods depending upon their location. After logging they tend to reforest with species likely never to be merchantable. The greater portion of the forest area is in creek bottoms and swamps.

Diversified farming is practiced and for the most part farm lands are in excellent cultivation. While little new land is cleared no old lands are abandoned. Farms range in size from 40 to 500 acres. Improved lands are subject to severe washing in the more hilly sections. The larger streams overflow at frequent intervals and by far the largest acreage of waste land is of the overflow type. Three-fourths of the county has general stock law.

Lumbering is not an important industry in Titus County. At the present time nine small mills produce approximately 900,000 feet of lumber annually. They are usually operated in connection with cotton gins and run very irregularly.

Tie cutting operations are practically at a standstill. Individual owners supply a very limited demand and the suitable timber is about exhausted. No stave operators are cutting in the county. One heading mill, however, consumes approximately 2,500 cords per year, the raw material being shipped from as many as 16 surrounding counties. A few cars of kindling are sold to the local railroads annually.

Public sentiment is opposed to burning the woodlands, and fires seldom do serious injury. Reproduction of the more desirable species, however, is lacking and more attention should be paid to the growing of woodlot products.

TRINITY COUNTY.

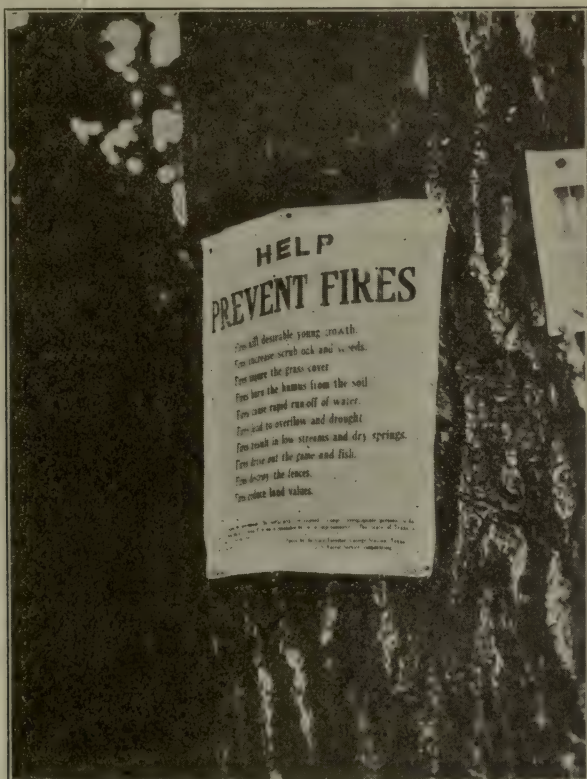
Trinity County is peculiarly situated in the East Texas pine timber belt. The eastern half lies within the longleaf region; the western half within the shortleaf region, and the southern boundary coincides with the northern boundary of the loblolly region. The county is, therefore, the meeting ground of the three commercial pines of East Texas. The land surface is generally level in the eastern portion, but more hilly or rolling in the western. The Trinity and Neches Rivers drain the county toward the south and east. Soils range from light, sandy loams to dark, clay loams and for the most part produce excellent crops. Public roads show much improvement. About 102 miles of mainline and 28 miles of logging railroad are operated in the county.

The land area may be divided as follows:

Approximate total area.....	450,560 acres.
Virgin timber lands.....	55,000 acres.
Second growth lands.....	150,000 acres.
Culled and cut-over lands.....	160,000 acres.
All other lands.....	85,560 acres.

The virgin timber is mainly longleaf pine, located in the northern portion of the county. Some shortleaf is found in the southern part. The timber is held in large tracts by the lumber companies.

Second growth lands comprise not only such areas as were logged



Forest Fire Notices, Posted in East Texas Woodlands, Call Attention to the Damage Resulting from Fires.

during the early days of the lumber industry but also a large acreage from old fields which have reverted to forest. Second growth timber for the most part is mixed hardwoods and shortleaf pine although a few comparatively large areas of young longleaf are located in the county.

Recently cut-over lands are found in all sections of the county, but due to fires and heavy cutting young growth is exceedingly scarce. A large proportion of the cut-over lands is suitable for farming purposes.

Farms are small, but agricultural conditions are improving. The lumber industry has a tendency to retard development. Only a small

acreage of new land is cleared annually, but there is no tendency to abandon older lands. Large numbers of cattle, but only a few sheep and goats, are kept on the open range. No part of Trinity County is under general stock law.

The lumber industry dates back 35 years. Five mills, one of 100 thousand, one of 75 thousand, and one of 40 thousand feet daily capacity, the other two comparatively small and irregular in their cut, produce approximately 40,000,000 feet of lumber annually. At this rate the industry may continue for 10 years longer.

About 54,000 oak and 6,000 pine ties are cut annually. All ties are hewn and cutting methods are exceedingly wasteful. The tie industry cannot continue at this rate of production for more than a few years. Fuelwood to the extent of 25,000 cords is cut yearly. In former years the output of railroad piling averaged 5,000 pieces annually, but now has practically disappeared through scarcity of suitable timber.

The fire problem is serious in Trinity County. Practically the entire area, outside of improved farm lands, burns over annually. Pine reproduction on the burned areas, even where there is a sufficient number of seed-bearing trees, is noticeably lacking. Seedling and sprout growth of mixed hardwoods on the other hand is prolific. In view of the lack of pine reproduction and the estimated life of the present commercial timber stands there will be a scarcity of timber in Trinity County within a comparatively few years. The present widespread practice of burning the woodlands should be discontinued.

TYLER COUNTY.

Tyler County lies entirely within the longleaf pine region. The land surface is broken and hilly in the northern and northwestern portions but becomes more level or slightly rolling toward the south. Drainage is entirely through the Neches River. Soils vary from very rocky and gravelly in the north to light, sandy loams in the south; a small area of black land is found in the north-central section. Streams are subject to frequent overflow. Public roads show but little improvement. Approximately 35 miles of mainline and 12 miles of logging railroad are operated in the county.

The land area may be divided as follows:

Approximate total area.....	592,000 acres.
Virgin timber lands.....	35,000 acres.
Second growth lands.....	40,000 acres.
Culled and cut-over lands.....	435,000 acres.
All other lands.....	82,000 acres.

Virgin timber lands support a growth of longleaf pine and are owned almost exclusively by non-residents. The timber is in scattered tracts, mostly in the north-central and southern portions of the county. It is estimated these areas will be cut out in not more than 10 years.

Second growth stands are of old field origin. Although second growth lands for the most part support a fair crop of young timber but little importance is placed upon its future value.

Culled and cut-over lands are timbered with more or less heavy stands depending upon the time in which they were logged. Those cut in the early operations will now furnish a second cut of from 2,000 to 5,000 feet of longleaf pine per acre. Those cut within the past five years have been practically stripped of their timber. Pine reproduction is almost entirely lacking both by reason of the stripping and the effect of frequent and severe fires. Mixed hardwood growth is slowly taking possession of these areas. A large per cent of the lands in this class may be considered as having agricultural value.

Agricultural conditions show improvement over former years both in methods of management and diversification of crops. Farms are small in size and while the tendency still is to clear new land and abandon old lands the acreage of improved farmland is increasing each year. Log rollings, in connection with clearing land, are common, at least ten being reported during the past spring. Farm lands are subject to severe washing in the more hilly sections. Agricultural development is somewhat retarded by the lumber business and there is a tendency for large owners to hold their lands. No part of the county is under general stock law.

Lumbering operations have been carried on for 25 years. Five mills, two with 75 thousand, one with 30 thousand daily capacities each, and two small and irregular in their cut, produce not more than 25,000,000 feet of lumber annually. There is only one combined sawmill and cotton gin in Tyler County. Although the virgin timber will probably be cut within the next 10 years, it is estimated that the present output of lumber may continue for many years in view of the extent and value of culled and second growth lands.

About 8,000 acres are now being cropped for turpentine, the cup and gutter system being used. The cutting operations produce approximately 50,000 white and post oak, 8,000 red and pin oak, and 2,000 pine ties annually. The present rate of cutting cannot be maintained longer than eight or ten years. Not less than 100,000 white and post oak staves are cut annually. This industry cannot continue long at this rate. Practically no fuelwood is shipped out of the county. Probably 115,000 fence posts are cut annually. Among other forest products are 35,000 telephone and telegraph poles, 500 mine timbers, and 50 squared timbers for export. All but the last may continue indefinitely.

Present methods of logging are stripping the timber lands and fires are frequent. Pine reproduction is almost entirely absent and what reproduction is present consists of oak and gum, upon which burning has little, if any, effect. The general sentiment in the county appears to favor burning and not less than 75 per cent of the area burns over annually. Under these conditions a second growth of pine timber on lands recently logged is impossible.

UPSHUR COUNTY.

Upshur County lies entirely within the shortleaf pine region, but adjacent to the post oak region. The land surface is generally hilly and broken and drains mainly into the Sabine River. Soils vary from light, sandy loams to those of the darker, heavier, bottomland types and in the main are well drained. Valuable iron ore deposits are found in the

southern portion of the county. Public roads are being slowly improved. About 96 miles of mainline railroad serve the county.

The land area may be divided as follows:

Approximate total area.....	337,280 acres.
Virgin timber lands.....	Negligible.
Second growth lands.....	65,000 acres.
Culled and cut-over lands.....	125,000 acres.
All other lands.....	147,280 acres.

There are practically no virgin timber areas of commercial value in Upshur County. Mixed hardwoods of scrubby growth and undesirable species occupy a small area.

Second growth lands support stands of shortleaf pine and mixed hardwoods. The best areas are located in the eastern portion of the county. A large acreage in this type is of old field origin and scattered tracts of old field pine are now producing mine props. The future value of the timber is fast becoming recognized.

The timber on the culled and cut-over areas is mostly pine with a small percentage of sweet gum and oak in the mixture. Mills are now cutting such timber as was left by earlier logging operations but which has since grown to merchantable size. While the greater proportion of these lands should be kept forested there is yet a considerable area suitable for agriculture.

Agricultural operations consist of general farming, stock raising, and fruit growing. No lands are being abandoned, but at the same time there is little tendency to clear new lands. Farms range from 400 to 1,000 acres in size. Eroded areas, pasture, and hillside lands are found in all sections of the county. All such areas, however, may be utilized for farming, grazing or timber growing if properly handled. All of Upshur County is under hog law and about one-fourth under general stock law.

Lumbering has ceased to be an important industry. Operations have been carried on for more than 40 years, but on a gradually decreasing scale. At the present time 13 small mills produce not more than 6,500,000 feet annually.

Approximately 25,000 pine, sweet gum, and oak hewn ties and from 25,000 to 30,000 mine props are produced annually. One small spoke and stave factory and two small shingle mills are being operated in the county. One box and crate factory consumes not less than 5,000,000 feet of gum annually.

Grass and woodland fires are still frequent in Upshur County. They are set either carelessly or in the belief that such burning will reduce the growth of scrub hardwoods and weeds. The present condition of the burned over areas with their non-merchantable growth of timber should discourage this practice. This county is an example of the varied and extensive forest products available from second growth forests after the lumber industry has ceased to be important. In after years the second growth in every county becomes a means of increasing the income on the farms.

VAN ZANDT COUNTY.

Van Zandt County, with the exception of a very small acreage in the extreme southeastern corner, not more than three per cent of the total area, which lies in the shortleaf pine region, is located entirely within the post oak region. The land surface is level to slightly rolling and drains into the Sabine, Trinity, and Neches Rivers. The small tributary streams generally become dry during periods of dry weather. Soils range from light loams to heavy, black waxy. Several small, scattered deposits of iron ore are found in the northern portion. Public roads for the most part are in excellent condition. Not more than 33 miles of mainline railroad are located in the county.

The land area may be divided as follows:

Approximate total area.....	561,280 acres.
Virgin timber lands.....	Negligible.
Second growth lands.....	Negligible.
Culled and cut-over lands.....	225,000 acres.
All other lands.....	336,280 acres.

The timbered area of Van Zandt County may be said to consist of mixed hardwoods on cut-over lands. The present stands are valuable only for fence posts and fuel. Clear cutting in the past and periodic burning have prevented reproduction and resulted in the present low productive forests. The greater proportion of these lands are agricultural and are being placed on the market.

Diversified farming is the principal agricultural pursuit. A large acreage of new land is cleared annually and none is being abandoned. New settlers are coming in from the adjoining counties. Farms average 100 acres in size and there is but little soil erosion on improved lands. Nearly all the county has a general stock law.

The lumber industry began 35 years ago and has now practically disappeared. Six small, portable mills are cutting very irregularly and chiefly to supply local needs. Their total annual output approximates 8,000,000 feet and at this rate they may operate indefinitely.

There is no activity in the stave or tie industries. Fence posts are cut for local consumption only. Fuelwood to the extent of about 100 cars annually is shipped out of the county.

Because of the closeness of cutting and the more or less frequent burnings, reproduction of the desirable timber species is practically absent. There is an excellent market for lumber, shingles, and other forest products and farm woodlots should be managed so as to supply this demand and bring added returns to their owners.

WALKER COUNTY.

Walker County lies within the extreme northern range of loblolly pine. The broken and hilly land surface is drained by numerous small streams into the Trinity and San Jacinto Rivers. Soils range from light sands to the heavy, river bottom types. All public roads are graded. More than 50 miles of mainline railroad, some of which is used for logging purposes, and 16 miles of logging railroad traverse the county.

The land area may be divided as follows:

Approximate total area.....	482,560 acres.
Virgin timber lands.....	250,000 acres.
Second growth lands.....	35,000 acres.
Culled and cut-over lands.....	68,000 acres.
All other lands.....	129,560 acres.

Virgin timber stands are located in the northern and southern sections and by far the greater acreage supports stands of loblolly pine. A comparatively small acreage consists of mixed hardwoods in the bottoms. The pine timber is owned in large tracts by the lumber companies. Logging on virgin timber lands is not proceeding very rapidly; in some instances timber deeds allow a time limit of 20 years in which to remove the timber.

Old field second growth stands are found in scattered tracts over the county. The future value of the timber is not recognized.

Approximately 40,000 acres of culled lands are found in the county. The timber on these areas will cut from 300 to 1,000 feet per acre. Cut-over areas have been logged within the past five years and are practically stripped of their timber. These lands are reproducing to mixed hardwoods and some pine where fires are kept out. Very little land in this class is suitable for agriculture.

Some progress is being made in general methods of farming. A small acreage is cleared annually and at the same time there is a decided tendency to build up older run-down farm lands. Timber is burned when clearing land. Farms range in size from 20 to 2,000 acres and if not terraced are subject to severe washing. Three-fourths of the county has hog law.

Although lumbering operations date back 25 years they have not been conducted on a very large scale and the bulk of the virgin timber remains to be cut. At the present time 13 mills, one of which cuts 150 thousand feet daily, the remainder small and irregular in their output, produce approximately 30,000,000 feet of lumber per annum. At this rate the timber is growing practically as fast as it is being cut.

About 10,000 ties, 75 per cent of which are pine, are cut annually. The easily accessible tie timber will be exhausted within the next few years even at this small rate of production. The fuelwood industry is a purely local one conducted by the farming population. There are perhaps 50 small, portable shingle mills in the county, but their output is small and irregular.

The fire problem is a serious one in Walker County. Approximately 60 per cent of the total area burns annually and as a consequence a mixed hardwood growth is taking possession of the logged pine lands. Such a condition is deplorable notwithstanding the extent of the timber lands as yet untouched.

WOOD COUNTY.

Not more than 20 per cent of the total area of Wood County, the extreme eastern portion, lies in the shortleaf pine region, the remaining 80 per cent being within the post oak region. The land surface, hilly in the northern but more rolling to level in the southern portion, drains to the

south and east into the Sabine River. The larger streams are subject to overflow. Soils vary from light sand to dark, heavy loams underlaid by a red clay subsoil. Practically all the public roads are graded. More than 69 miles of mainline but only five miles of logging railroad are operated in the county.

The land area may be divided as follows:

Approximate total area.....	440,320 acres.
Virgin timber lands.....	20,000 acres.
Second growth lands.....	Negligible.
Culled and cut-over lands.....	227,000 acres.
All other lands.....	193,320 acres.

Not more than one-fourth of the virgin timber lands are pine, the remainder supporting a growth of mixed hardwoods. The best bodies are located in the southern and eastern portions of the county. Land and timber are owned jointly in large tracts by the lumber companies.

Although their future value is fast becoming recognized the present area of second growth timber lands is negligible. There are a few such areas of pine and hardwoods, both pure and in mixture, the latter type predominating.

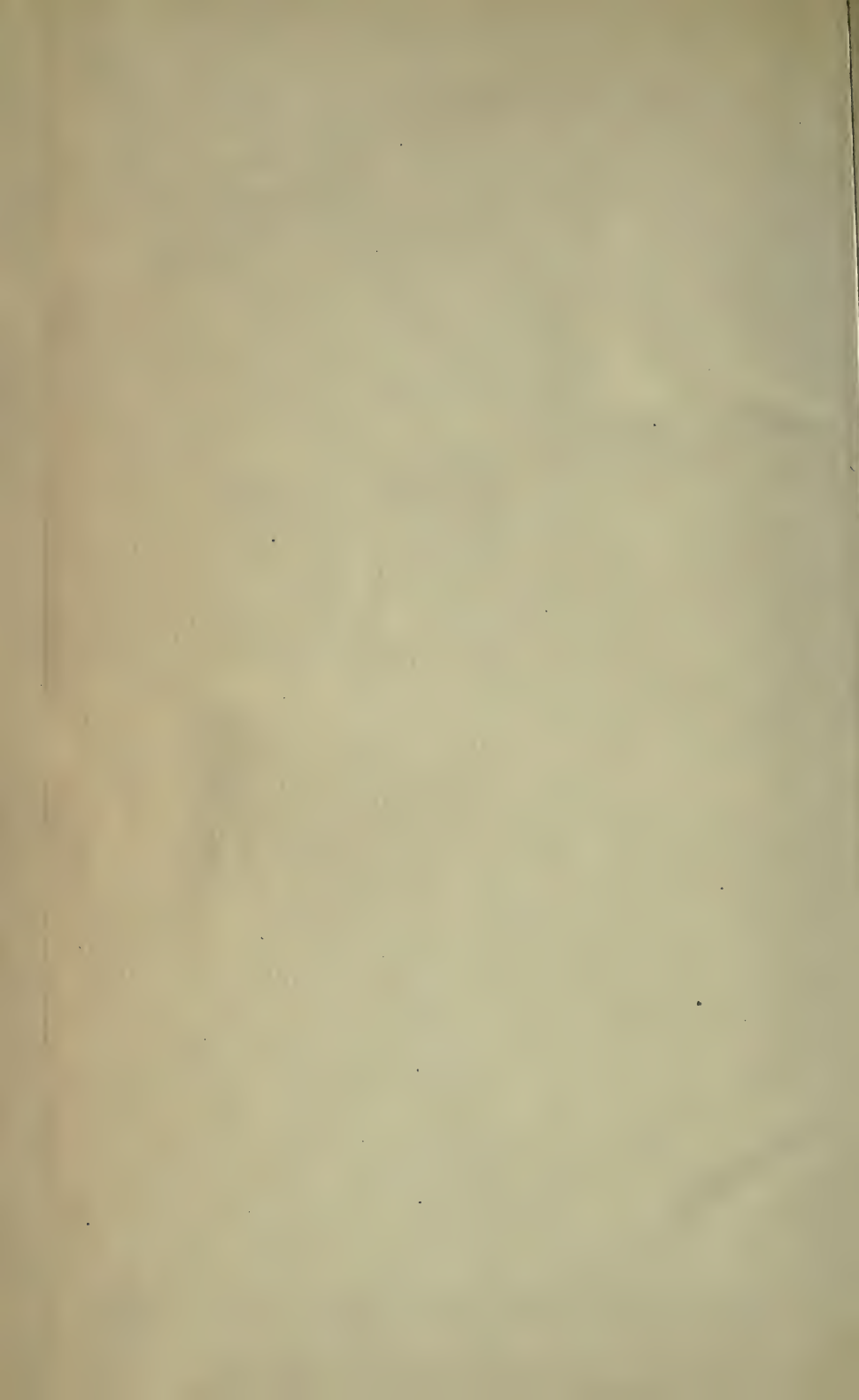
Culled and cut-over lands date from 35 years ago to the present time and comprise a large acreage. Areas logged under early methods now support a growth of good timber, pine being found in the east and mixed hardwoods in the west. Much of the land in this class suitable for farming has been placed on the market.

Fruit growing and diversified farming are the principal agricultural pursuits and the county is settling up rapidly. No old lands are being abandoned and a comparatively large acreage of new land is put under cultivation annually. Farms range in size from 40 to 300 acres, the tendency being toward the larger acreage. One-third of the county is under hog law and about one-fifth under general stock law.

The lumber industry has been in operation for more than 35 years. At the present time, however, the industry is comparatively small. Twenty-five small mills of the portable type, four of which are cutting hardwoods and one of which is operated in connection with a cotton gin, run very irregularly and produce not more than 10,000,000 feet annually. In view of their irregular output most of these mills will cut indefinitely.

Not more than 20,000 hewn ties, mostly oak, are cut yearly. At this rate the industry cannot last many years. Tie operators are cutting their waste into cordwood. Approximately 7,000 cords of fuelwood and from 10,000 to 12,000 mine props are shipped out of the county each year. Fence posts are cut only for home consumption. One other industry, a box and crate factory, consumes not more than 1,000,000 feet of gum yearly.

Close and long continued cutting may be assigned as the primary reason for lack of reproduction and the absence of second growth in Wood County. Grass and woodland fires are an important secondary reason. The present supply of timber is poor both in quality and size and there is not much prospect of a future supply. Local demand for forest products warrants a general development and improvement of farm woodlots as a solution of the problem.



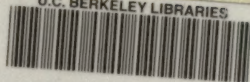
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